IMPERIAL INSTITUTE

INDIAN TRADE ENQUIRY

REPORTS ON LAC, TURPENTINE AND ROSIN

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REPORTS of the INDIAN TRADE ENQUIRY

HIDES AND SKINS
RICE
OIL-SEEDS
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ETC. ETC.

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REPORTS ON LAC, TURPENTINE AND ROSIN

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IMPERIAL INSTITUTE

Committee for India

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INDIAN TRADE ENQUIRY

Special Committee on Gums, Resins and Essential Oils

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PREFATORY NOTE

In August 1916 the Secretary of State for India invited the Imperial Institute Committee for India to conduct an enquiry into the possibilities of further commercial usage in the United Kingdom of the principal Indian raw materials. It was also proposed that the enquiry should include the possibility of the usage of these materials in other parts of the Empire.

The invitation was accepted by the Committee for India, and a number of Special Committees were formed to deal with the principal groups of materials selected for inclusion in the Indian Trade Enquiry.

The groundwork for the consideration of the various Committees has been supplied from the information as to the raw materials concerned which has been systematically collected at the Imperial Institute, chiefly in the Scientific and Technical Department and in the Technical Information Bureau.

The Committee have also had at their disposal the numerous reports made by the Scientific and Technical Department of the Institute during recent years on the composition and commercial uses and value of Indian raw materials, and have also utilised the collection of raw materials of India derived partly from Technical Departments in India and partly from commercial sources which are included in the Indian Section of the Public Galleries and in the Reference Sample Rooms of the Institute.

It has now been decided, subject to certain reservations made by the Secretary of State, that the reports of these various Committees which have been forwarded by the India Office to the Government of India should be published.

The reservations referred to are that at the request

of the Government of India paragraphs in certain of the reports as presented should be omitted, such paragraphs being indicated by asterisks, and that it should be stated that the reports represent the personal opinions of the members of the Committees, and that the Secretary of State is in no way committed to accept these opinions.

(*Signed*) C. C. McLeod.
Chairman, Committee for India.

November 1919.

CONTENTS

REPORTS ON LAC, TURPENTINE AND ROSIN

I

THE TRADE IN LAC

THE Special Committee appointed by the Committee for India of the Imperial Institute to consider, in connection with the Indian Trade Enquiry, the condition of and possibility of increasing the trade of the United Kingdom and other parts of the Empire with India in Gums, Resins and Essential Oils, consisted of Mr. A. Yusuf Ali (Chairman), Sir James Dunlop Smith, K.C.S.I., K.C.V.O., and Professor Dunstan, Dr. T. A. Henry, of the Imperial Institute Staff, acting as Secretary. At its first meeting the Special Committee decided to deal first with the trade in lac resin, and to co-opt Colonel S. H. Godfrey, C.I.E., late Political Agent in Baghelkhand, to assist in its work, in view of his special experience in connection with lac and other forest produce in Central India. Seven meetings have been devoted to this subject.

Statements as to the present and pre-war position of the trade in lac resin have been supplied to the Committee by the following firms :

Shellac Brokers.—Messrs. Lewis and Peat, Messrs. French and Plucknett, Messrs. Adair & Co.

Shellac Traders.—Messrs. C. W. Waters, Ltd.

Shellac Merchants and Shippers.—Messrs. Ralli Brothers, Messrs. E. D. Sassoon & Co., Messrs. Becker, Gray & Co., Messrs. Turner & Co.

Varnish Makers.—Messrs. T. S. Jackson & Sons.

Electrical Trades.—Messrs. Henley's Telegraph Works Co. Ltd., Messrs. Berkeley and Young, Ltd., Messrs. Edison & Swan United Electric Light Co. Ltd., The British Electrical Federation, Ltd., Messrs. Callenders

Cable & Construction Co. Ltd., Messrs. Siemens Brothers & Co. Ltd.

Furniture Makers.—National Federation of Furniture Manufacturers.

Sealing-Wax Manufacturers.—Mr. J. F. Craddock, Messrs. H. Hill & Sons, Ltd., Messrs. Waterston & Sons, Ltd.

Hat Manufacturers.—Messrs. W. Macqueen & Co. Ltd., Messrs. F. J. Elliott & Co., Messrs. Tress & Co. Ltd., Messrs. Christy & Co. Ltd.

Crape Manufacturers.—Messrs. Courtaulds, Ltd.

Gramophone Record Makers.—The Gramophone Co. Ltd., Messrs. J. E. Hough, Ltd.

The Committee are much indebted to all these firms for the full and frank replies given to the questions put to them and for the time and trouble they have expended in supplying information. The Committee have also had the advantage of the cordial assistance of Colonel S. H. Godfrey, C.I.E., Mr. L. Mercer, C.I.E., and Mr. A. S. Judge, on specific points connected with lac cultivation and the present position of the industry in India and Burma. Certain questions have also been referred to the Committee on Raw Materials appointed by the Association of Chambers of Commerce of the United Kingdom in connection with the work of the Imperial Institute, and this part of the enquiry is still in progress.

Lac Resin

Lac is a resinous incrustation produced by the lac insect, *Tachardia* (*Coccus*) *lacca,* on certain trees, which serve the insect as host plants, in India, Indo-China and Siam. The life-history of the insect is well known and has been described frequently, so that no further reference need be made to it here, beyond stating that there is practically no real cultivation of lac in any of the countries in which it is produced, the usual procedure being that the lac collectors merely inoculate branches of suitable trees with brood lac. A good deal of attention has been given by the Forest Departments in India to the best means of producing a good lac crop, such as proper pruning of the trees to produce an abundance of succulent shoots, provision of

" bridges " to enable the swarming insects to reach succulent shoots easily, and better methods of collection, but there is no evidence that these improvements have been widely adopted.

The insect swarms twice each year, usually in July and in December or January, and the two swarms generally complete their life cycles in about six months, *i.e.* December and June. The collection of the lac takes place at any time when labour is available, but as a rule from June to July for the Baisakhi crop, and in October and November for the Katki crop. It should be added that the crop does not deteriorate if left on the trees, and is often collected in seasons not immediately subsequent to that in which it is formed. The usual practice is to cut or break off the resin-encrusted twigs before the insects have swarmed, but this procedure is uneconomical as it destroys large numbers of the insects and, therefore, hinders their spread to other trees. Moreover, the lac collected at this stage contains the maximum amount of colouring matter, which has to be washed out in the preparation of the resin. A better method of collection is to break off by a twisting movement the resinous incrustation only, after the insects have swarmed, leaving the branch of the tree intact. This improved method of collection has been adopted by the collectors of the Esociet factory, to be referred to later, and by Zamindari workers elsewhere in India, but the lac so collected forms as yet but a small proportion of the total output. The resin-encrusted twigs are cut into small pieces, known as " stick-lac," which are taken to the factory, where the resin is removed by beating the twigs with mallets, or, in up-to-date factories, by passage through machine-driven crushing rollers. In this process three products are obtained: (1) de-resinated twigs, generally used as fuel; (2) dust and waste, which is usually sold locally to makers of bangles and toys; and (3) seed-lac. The last is next washed with water to remove the red colouring matter (lac-dye), which was at one time the most important commercial product of the lac insect, but is now of little or no value for export, though it still has some local value as a dye. The washed seed-lac (grain-lac) is sometimes exported as such, but more usually it is converted

by melting and other special treatment into shellac and button-lac, in the course of which it is coloured by the addition of a small amount of orpiment, and its melting-point lowered by the incorporation of common rosin.

The products of the lac insect in which there is any export trade are stick-lac, seed-lac, or grain-lac, button-lac, garnet-lac, shellac and lac-waste. Of these, by far the most important for export purposes, so far as India is concerned, is shellac.

The World's Production of Lac Resin

Though resin-secreting insects occur in Madagascar, Uganda and elsewhere, and the true lac insect has been introduced into Ceylon and Egypt, there is no commercial production of lac resin outside India (including Burma), Indo-China and Siam. It is not known to what extent production can be increased in Indo-China and Siam ; but it is certain that India's output can be greatly extended if necessary.

The exports of all forms of lac resin from India, Indo-China and Siam average annually about 425,000 cwts., valued at £1,350,000. Of this, India contributes nearly 400,000 cwts., the rest being about equally divided between her two competitors. India's position is even more predominant than these figures indicate, because much of the lac exported from Indo-China and Siam is stick-lac, whilst that from India is mostly clean lac resin in the form of shellac, button-lac or seed-lac. The actual figures for the different forms, averaged from the export returns of the three countries in recent years, are as follows :

Average Output in Recent Years

(*cwts. per annum*)

Kind.	India. 1910–11 to 1914–15.	Indo-China. 1910–13	Siam. 1911–12 and 1913–14.
Shellac	325,698	nil	nil
Button-lac	29,970	nil	nil
Seed-lac	11,955	nil	nil
Stick-lac	4,359	11,124	12,750
Other kinds [1]	24,746	nil	nil
Gum-lac [2]	nil	1,422	nil
Total	396,728	12,546	12,750

[1] *Includes garnet-lac, waste-lac, etc.*

[2] *Probably mostly seed-lac.*

It is clear from these figures that India has practically a monopoly in the production of lac resin, and that this monopoly is especially complete in those forms of lac resin, such as shellac, which need skilful manipulation in their preparation for the market. It is possible that Siam and Indo-China might increase their production of stick-lac, and the former begin to produce seed-lac ; but with their present supply of skilled labour it is unlikely that they could produce shellac in competition with India, unless machinery were introduced for this purpose and the whole industry properly organised. In this connection it is worth noting that a recent issue of a German technical journal (*Farben Zeitung*) points out that after the war Germany will have difficulty in obtaining shellac from British Territories, and proposes that steps should be taken to get supplies from Siam.

Distribution of Supplies of Lac Products

The chief destinations of exports of lac resin from India, Indo-China and Siam are as follows :

United States.—In the years 1910-11 to 1914–15 the United States took on an average 171,803 cwts. of lac resin, made up as follows : shellac, 155,287 ; seed-lac, 5,769 ; button-lac, 1,459 ; stick-lac, 341 ; other sorts, 8,947. These figures are from the Indian official export returns. The United States import returns for 1911–15 show a yearly average import of 167,908 cwts. direct from India, and a total average yearly import of 173,260 cwts., the balance being taken chiefly from the United Kingdom and Germany. The average annual re-exports for the same period were 4,273 cwts., chiefly to Canada. The amount retained in the United States for consumption in this period, therefore, was 168,987 cwts. annually, which is about 42 per cent. of the Indian production. The United States is, therefore, undoubtedly the most important market for India's output of lac resin.

United Kingdom.—The United Kingdom, according to the Indian Trade Returns, received during the period 1910–11 to 1914–15 on the average 99,788 cwts. of lac resin per annum, made up as follows : shellac, 72,879 ;

seed-lac, 5,120; button-lac, 17,747; stick-lac, 3,718; other sorts, 324.

According to the import returns of the United Kingdom, the average annual imports (1911–1915) of shellac (which in these returns appears to include all varieties of lac resin) were 106,489 cwts., of which on the average 45,718 cwts. were re-exported. Practically all these imports come direct from India, the amount received indirectly from India, or from the other producing countries, being on the average only 1,674 cwts. The total imports of lac resin to the United Kingdom, therefore, are equivalent to about 26·8 per cent. of India's total output.

Germany.—During the period 1909–10 to 1913–14 India exported direct to Germany 83,212 cwts. of lac resin annually, made up as follows: shellac, 60,558; seed-lac, 650; button-lac, 5,913; stick-lac, 437; other sorts, 15,654.

The German import returns for the period 1909-13 show an average annual import of lac resin amounting to 123,146 cwts., made up as follows: shellac, 102,072 cwts.; "gum-lac," 21,074 cwts., of which an average of 112,732 cwts. came direct from India. There is a remarkable discrepancy between this figure and that given by the Indian Export Returns, the difference being no less than 29,520 cwts. The re-exports from Germany during the same period averaged yearly 26,500 cwts., so that the actual annual average consumption in Germany during this period was 96,646 cwts. There seems to be no reason why Germany's re-export trade in lac resin to Russia and Scandinavia should not be done direct by India, or through the United Kingdom if that is more convenient.

It should be noted that according to the Indian Trade Returns, whilst the United States and the United Kingdom predominate in the shellac, seed-lac, button-lac, and stick-lac trade of India, Germany is usually by far the largest buyer of "other sorts," including waste and refuse; though the United States has also in recent years begun to buy considerable amounts of these poorer qualities. These low grade "other sorts" are believed to have been used in Germany for making cheap varnish, which was to a certain extent exported to India.

Other Countries.—France ranks fourth as a buyer of Indian lac resin, and also takes the whole of the stick-lac produced in Indo-China ; Holland ranks fifth. The next most important buyer is Austria-Hungary, followed by Japan, Italy, Belgium and Australia ; Canada and Russia are both fairly important markets, but receive their supplies chiefly *viâ* the United States and Germany respectively.

Industrial Uses of Lac Resin

Lac resin is one of the most important resins of commerce, and owes this position partly to properties (such as high resistance to the action of air and moisture, adhesiveness and high electrical resistance) which it shares with all resins, but chiefly to the fact that its ready solubility in alcohol and its low melting-point render it easy of application. There is, so far as is known, no satisfactory substitute for lac resin among natural resins, and so far there is no indication of the possibility of the manufacture of an artificial substitute, though artificial resins which can be used for it in some instances are known, and these may possibly be improved and added to. The synthetic production of shellac is a contingency which need not for the purposes of this report be seriously considered. On the whole, it seems reasonable to suppose that, if India organises the lac industry on sound lines and takes care to be in a position to supply enough lac of good quality at a reasonable price, the industry will be established even more firmly than at present, and her practical monopoly will be maintained and strengthened.

The principal uses of lac resin are :

1. *As an electrical insulating agent.* Chiefly for special insulators having paper or mica (micanite) as a basis, and for insulating varnishes.

2. *As a stiffening material for felt, straw, etc.*, for hats, and for crape.

3. *As a preservative coating for wood and metal* in the form of varnishes (spirit and water soluble) and lacquers. For these purposes it is employed in a great variety of industries, including the manufacture of shell parts.

4. *As an adhesive material* in special cements, sealing-wax, dry mountants, gramophone records, etc.

Certain of the above purposes make lac an almost indispensable material for the manufacture of munitions of war, and it is also used in the preparation of certain kinds of military signalling lights. Lac resin is therefore to be regarded as an important war material, and from this point of view it is essential that its production should be safeguarded and that there should always be an ample stock in the United Kingdom.

Present and Pre-War Position of the Lac Industry

The lac industry in India is not well organised : there is no effective central control of the granting of leases for the cultivation and collection of lac, and the conversion of stick-lac into the finished resin (grain-lac, button-lac, shellac, etc.) is left for the most part to small manufacturers, with the result that little has been done to improve methods of manufacture or the forms in which the resin is marketed. At the most, three or four factories only have had in the past the benefit of skilled, scientific supervision and experience, and that has not always been British. The methods of trade are cumbrous. There intervene between the collector of the stick-lac and the actual industrial consumer of the resin in this country as many as seven persons, viz. the lac manufacturer, the broker in India, the merchant and shipper, a banker, the London broker, the shellac trader, and sometimes the small dealer and manufacturer of shellac varnish. Large buyers are able to dispense with several of these intermediaries, and certain of the lac-resin factories in India, under the control of Europeans, have sold direct, or at one remove, to British manufacturers ; but such direct sales are the exception. This complex method of trading is probably the chief factor which has made shellac one of the most speculative commodities on the market. It is not easy for the consumer on this side to take any action to improve the position, because the quantity of shellac used by one consumer is generally comparatively small, and effective concerted action is difficult to arrange between a large number of small users in different industries with varied interests.

Another important matter is the frequent adulteration

of the manufactured forms of lac resin, especially shellac and button-lac. The evidence placed before the Committee shows that button-lac adulterated with as much as 50 per cent. of common rosin has come on this market. Indeed, one witness stated that when shellac is dear, the material offered for sale from ˜ dia may contain anything from 5 to 50 per cent. of rosin. It is generally stated that shellac cannot be made unless at least 5 per cent. of rosin is added, and so long as the trade demands shellac and button-lac, in preference to other forms, admixture to this extent with rosin must be submitted to ; but it is important to remember that the addition of rosin, even to the extent of 5 per cent., detracts from the special qualities of lac resin, and assists the trade of the purveyor of natural and artificial substitutes, who can compete more easily with adulterated lac resin than with the genuine article. The large buyer protects himself by buying on the results of analysis, but the small buyer is unable to do this, as his small purchases do not warrant his paying fees for analysis.

The Committee are assured that in the electrical industry, and in the manufacture of hats and crape, unadulterated lac resin is essential ; and, though they have not investigated this point so thoroughly in connection with other industries, they have no reason to believe it is less important there. In the case of some forms of spirit varnish and lacquers, more " body " is required than is obtained by using grain-lac alone, and for this reason shellac or button-lac containing rosin and orpiment is preferred ; but varnish manufacturers also object to an excess of rosin.

Possible Increased Usage of Lac Resin Within the Empire

Since the outbreak of war there has been no falling off in the demand for lac resin that can be traced in the trade returns available. Increased exports, especially to other parts of the Empire and to the United States, have accounted for most of the quantities that were formerly exported to enemy countries, and, in consequence of the demand, the price has advanced by hundreds per cent.

In addition, some countries which used to buy indirectly are importing more direct from India. This increased use of lac resin in allied countries is probably largely accounted for by the use of the resin in the manufacture of munitions.

The Committee particularly desire to draw attention to the possibility of an increased usage of lac resin in India, if the production of Indian lac-wares can be developed. No statistics are available showing the quantity of lac resin used in India ; but the amount must be large in view of the large, though unorganised, production of lac-wares. The Committee have gone into this matter carefully, and have considered the results of enquiries made by the Imperial Institute among British importers of toys and other fancy lac-wares as to the possibility of creating a greater demand for these wares in the United Kingdom. The latter was before the war largely supplied with wooden toys and small wooden fancy wares by Germany and Austria-Hungary. Since the war these articles are being largely replaced by imports from Japan. The importers consulted by the Imperial Institute are of opinion that a market could be found in this country, and possibly also in the Dominions, for small Indian toy and lac-wares. The essential conditions for success are : (1) That the manufacture of and trade in these wares should be undertaken by responsible firms in India who can maintain stocks large enough to meet any reasonable demand and are prepared to undertake orders without having money advanced to them by the prospective buyer ; (2) that a large range of wares is produced from definite registered patterns, so that a buyer in this country may be able to order supplies by mere reference to a catalogue number, and to depend on delivery of the articles he requires by a definite date.

Action has already been taken by the Imperial Institute to obtain a representative collection of lac-wares from India for exhibition in London ; and, when this collection arrives, efforts will be made to interest importers in these wares and to place them in communication with producers. Advices have been received of the despatch of a collection of lac-ware toys from the Government of the United Provinces, and also of a collection kindly sent

by the Maharajah of Rewah. At present there is reason to believe that the action taken will be successful, possibly not at once, owing to freight difficulties and restrictions on imports, but certainly as soon as normal conditions are restored. There are also considerable possibilities of an increase in the use of lac resin in the United Kingdom and certain of the Dominions, particularly Canada and Australia, which are already important consumers. Almost every British manufacturer consulted in the course of the enquiry was of opinion that his industry could use more lac resin if it were placed in a position to compete on even terms with foreign competitors. Similarly there seem to be considerable possibilities of development in the use of the resin in several of the allied and neutral countries, so that, on the whole, there seems no reason to fear any falling off in the demand for lac resin, even if it became necessary or desirable to restrict by any means, exports to the countries with which the Empire is now at war.

Lines of Action Considered

The evidence placed before the Committee shows that the chief obstacles to a large extension in the use of lac resin in the United Kingdom are three in number :

(1) Fluctuations in the price of the resin.
(2) Adulteration of the resin.
(3) Competition of cheap, foreign-made goods containing lac resin.

The first two of these obstacles can apparently only be overcome by better organisation of the industry in India. For this reason the Committee have felt it desirable to embody in this report some suggestions on this subject for consideration in India. The Committee realise that this is essentially a subject for enquiry in India, and in putting forward these suggestions they merely desire to indicate lines of action which appear to be worth serious consideration as likely to lead to results advantageous both to India and the rest of the Empire.

In making these suggestions, regard has been paid to the various reports and monographs on the lac industry which have been published from time to time in India

by officers of the Forest Department and others, and it is believed that none of them are in conflict with the information given in these reports as to the needs of the industry.

The questions which appear to the Committee to require attention from this point of view are as follows :

1. Systematisation of the method of leasing concessions for the collection of lac.
2. Improvement in the cultivation and collection of lac.
3. Modernisation of the methods of preparing lac resin for the market.
4. Definition of the forms of lac resin, and action to prevent adulteration.
5. Simplification of the system of trading.
6. * * * * *

The closely-related question of the large share taken in the trade in lac resin in India before the war by firms partially or wholly alien will no doubt be dealt with by the Government of India as part of its general policy in this matter, and no special recommendations need be made on this question by the Committee. It should, however, be borne in mind that, if any distinction is made among trades as regards the extent to which trading by aliens should be permitted, that of lac resin (in view of the importance of this article for war purposes) should be classed with those, such as raw hides, in which effective British or Indian control is essential. The consumption of shellac for war purposes, and especially in the manufacture of shells, is very large.

In deciding how the six points mentioned above should be dealt with, it is necessary in the first place to consider to what extent intervention by Government is desirable. The Committee are interested to note that action has already been taken by the Indian States of Maihar, Nagod, Datia, Panna and Chhatarpur to modernise their lac industry, and that these States have established the Esociet lac factory at Maihar, which has proved successful. The Committee now suggest that similar action may be possible in British India, and they hope that eventually all the Indian States interested in the lac industry may

adopt a similar procedure. In this connection it should be pointed out that the people who have benefited most by the establishment of the Esociet factory are the Kols, Gonds, Baigars and other jungle tribes whose livelihood depends on the collection of forest produce such as lac. The extension of Government action in connection with the lac industry would be of advantage to these or similar people, who are always the first to suffer in times of famine or financial stringency in India.

1. *Method of Leasing Concessions*

The areas in British India in which lac is collected are partly zamindari tracts, and partly forests under Government control. The conditions under which leases and rights to collect lac are granted vary ; some of them are clearly designed to encourage cultivation and careful collection, others appear to neglect such considerations almost entirely. It seems desirable for the future of the industry that the method of granting leases should be systematised, and should include conditions which will ensure improved cultivation and collection of lac. What these conditions should be, and the best means of securing a systematised method of granting leases, would naturally be the subject of enquiry in India, but the Committee venture to draw attention to the method adopted in the case of certain forests in the Central Provinces, in which the right of collecting lac has been leased to the Esociet factory at Maihar for a period of five years on a sliding scale of royalties.

The Esociet factory was started on the suggestion of Colonel S. H. Godfrey, C.I.E., shortly after the outbreak of war, by the Darbars of Maihar and Nagod, to develop the forest resources of the two States, a small trading concern, the Eastern States of Central India Export Trust (known as Esociet), being formed by the two States to carry on this work. The factory was so successful that the company has now been enlarged, and the native States of Datia, Panna and Chhatapur admitted to shares in the concern.

The sliding scale of royalties worked in the case of the Damoh forests of the Central Provinces, in which collecting

rights for lac have been leased to the Esociet factory, was as follows [1] :

With T. N. shellac, selling at the following prices per maund in Calcutta (average for the month).	The royalty charged is as follows per maund of stick-lac (clean and dry) removed from the forest as certified by railway receipt.
Up to 30 Rupees	8 Annas
Between 30 and 35 Rupees	12 ,,
,, 35 ,, 40 ,,	1 Rupee
,, 40 ,, 45 ,,	1 ,, 8 Annas
,, 45 ,, 50 ,,	1 ,, 12 ,,
,, 50 ,, 55 ,,	2 ,,
,, 55 ,, 60 ,,	2 ,, 8 ,,
,, 60 ,, 65 ,,	3 ,,
,, 65 ,, 80 ,,	5 ,,
Over 80 Rupees	10 ,,

The total crop was to be reported to the Forest Department of the Central Provinces with railway receipt as evidence, before October 31 for the first (Baisakhi) crop, and before January 31 for the second (Katki) crop.

These figures are suggested merely as a guide ; the royalties would clearly have to vary according to local conditions.

This method, the Committee are assured, has proved satisfactory to both lessors and lessees. It ensures the lessees' continuance of their rights for a sufficiently long period (at least five years) to make it worth their while to see that cultivation and collection are properly carried on ; and it interests both parties in increasing the supply of lac available, but not necessarily in increasing the amount collected in any one year, though its tendency is in this direction.

In connection with this subject it may be worth while to give some attention to the lac trade in Burma which, though never very large, appears to have declined considerably in recent years. This trade is chiefly in stick-lac collected in Burma or imported from Western China, Karenni, and the Shan States, and to a small extent from Siam.

Regarding the decline in this trade the Collector of Customs at Rangoon says, in his Report for 1912–13, " For the five years ending 1907–8 prior to the imposition

[1] It is understood that a revised scale is now being negotiated.

of the export royalty,[1] the average value of exports to India was Rs.12·52 lakhs; the royalty appears to have seriously interfered with the trade. It will be interesting to see whether the revival now begun on account of the reduction of royalty will have any considerable development in the next few years."

The export royalty in Burma is levied on all forms of lac without discrimination as to value, and is mainly collected on stick-lac exported from Burma to other parts of India to be worked up into grain-lac, shellac, lac-wares, etc. In view of the importance of centralising in India, as far as possible, the lac trade of the world, it seems desirable that nothing should be done to divert stick-lac from contiguous countries into other than the natural channel of trade through Burma.

2. *Cultivation and Collection of Lac*

The Forest Departments in India have given a good deal of attention to this subject, and good methods of cultivation and collection are available, but are not used to any great extent. An improved system of leasing, such as that suggested above, would tend to a more general adoption of good methods. If, as is suggested below, the preparation of lac resin is in the future centralised in a few large factories, it will probably be easier than at present to ensure careful cultivation and collection, as it will be to the interest of the owners of large factories to take all steps necessary to safeguard their future supplies of raw material. The Committee suggest that the Government should take action to secure that cultivation and collection are properly carried on, and, apart from conditions laid down in the leases, the best method of ensuring this would appear to be the appointment of one or more officers whose special duties it would be: (1) to study and determine the best methods of cultivating and collecting lac; (2) to advise regarding regulations to be enforced on this subject; and (3) to demonstrate suitable methods to lac collectors, and to supply information to such collectors. These officers might be attached to the

[1] In 1908 an export royalty of Rs. 10 per 100 viss, equivalent to 4*s.* 2*d.* per cwt., was imposed, but was reduced in 1912.

staff of the forest departments of the provinces concerned. The organisation of the method of leasing concessions and of cultivation and collection is only suggested for the lac-bearing areas in the Government forests in British India. It would probably be so effective that it would spread to areas outside Government control, and to facilitate this process the Government might be prepared to lend Indian States and zamindari owners the assistance of their experts in drawing up regulations and in training new men if desired.

3. *Lac Factories*

At present the preparation of lac resin for the market is essentially a small-scale industry, carried on often by single families. It is not surprising, therefore, that the methods pursued are laborious and antiquated, and that adulteration of the resin is common. There are a few larger factories, controlled in some cases by British firms, and in these machinery has been installed ; but even in these factories for the most part the primitive methods of the Indian worker are merely imitated and quickened by machinery, and have not been materially superseded. There seems to be no reason, for example, why so large a proportion of the resin should be laboriously converted into shellac, instead of being exported as grain-lac. Any addition required to lac resin for special purposes might be made by the manufacturers themselves ; thus, if rosin is required, it could be added to the lac resin by the manufacturer. Many of the actual consumers of shellac and button-lac in this country, and probably also in the United States, appear to buy these forms of the resin merely because they are offered, and many of them appear never to have heard of grain-lac. As the resin has for most purposes to be dissolved in spirit before it can be used, it seems likely that a clean grain-lac free from dirt and dust would answer the purposes of many consumers even better than shellac, which has to have common rosin and orpiment added to it in the course of manufacture in India. Moreover, the use of grain-lac in place of shellac, button-lac, etc., would avoid the difficulty now frequently experienced with the latter forms that they soften and

become blocky in transit, and have to be broken up on arrival in this country. Enquiries are now being made by the Imperial Institute among British manufacturers as to the extent to which grain-lac could be substituted for shellac and button-lac. It is improbable that improvements of the kind suggested can be brought about, unless the preparation of lac resin for the market is undertaken in large, modern factories. It is remarkable that this has not already taken place merely as a result of the general tendency now exhibited by manufacturers in all branches of industry to control the ultimate sources of the supply of their raw materials. That it has not occurred so far in connection with lac resin is probably due to the fact that the resin is used in comparatively small quantities in a great variety of industries, and the pressure of scarcity of supply and high prices has not been sufficient to induce manufacturers to take action, and also because shellac comes largely from Indian States where Europeans and Americans may not operate without the sanction of the Government of India. It may, however, take place to some extent at any time, and in view of India's practical monopoly of the lac industry and trade, and the numerous small but important British and Indian interests involved, it is a question whether the Provincial Governments chiefly concerned in India may not desire to take action to secure some control of their part of the industry.

The success of the Esociet factory, supplied in large measure by lac collected in the forests of the Central Provinces, appears to show that the industry is one which can be worked effectively under Government control. A Government factory would be useful not only as a means of demonstrating the advantages of improved methods of manufacture, but could be used to develop in India industries in which lac is employed. Such a factory would serve as an example to teach the best methods of utilising stick-lac with a view to producing a uniformly clean and unadulterated article. The Committee are of opinion that at least one Government factory might with advantage be started in British India to manufacture lac resin from lac collected in the Government forests. The site of the factory would naturally be either in the United Provinces

or in the Central Provinces ; or a factory might be started in each, in an area in which supplies of lac under control of the Governments are available. The factory might be organised and managed on the lines adopted in the case of the Esociet factory. If, as there is no reason to doubt would be the case, this factory should prove successful, it would undoubtedly lead to the reorganisation of the whole industry in British India ; and the Government could in the light of these developments decide later on how far it would carry this policy of controlling the industry. It might, for example, be content to exert control by a system of licences to manufacture lac, licences being granted to British and Indian firms only. The Government would be abundantly justified in the policy of starting one or more factories by the necessity of having under its own control the means of producing enough lac resin for (1) the manufacture of munitions in case of war ; (2) the development of lac-using industries in India ; (3) the supply of its own requirements for lac varnishes, polishes, etc., the manufacture of which would be carried on as a subsidiary branch of the factory ; and (4) assistance to the jungle tribes. The action understood to have been taken recently by the Government of India in commandeering for war purposes 20 per cent. of the output of lac resin, is further evidence of the need for some measure of this kind.

Associated with the Government lac-resin factory, there might also be a factory for the manufacture of lac wares and toys, and a school in which this craft could be taught, and in which new designs for such wares could be prepared. Reference has already been made in the earlier part of this Report to the possibility of developing an export trade to this country in Indian lac-wares and toys, and this industry could undoubtedly best be started under Government auspices, as in no other way can the combination of craft education and special industrial organisation, which is needed to make such an industry successful, be secured. Something has already been done to revive certain of the Indian artistic crafts by the Department of Industries in the United Provinces, and if the Committee's proposals to start a lac-resin factory with a school and factory for lac wares attached to it, on the lines suggested above, be

accepted, the factory and school in the United Provinces might well be placed under the control of that Department.

4. *Definition of the Forms of Lac, and Action necessary to prevent Adulteration*

Reference has been made already in this Report to the prevalence of adulteration in the manufacture, especially of shellac and button-lac. It has been represented to the Committee by almost every British manufacturer consulted that steps should be taken to stop this practice, which is detrimental to the interests of the whole industry. The simplest method of dealing with this long-standing difficulty appears to be that several forms in which lac resin is exported should be defined, and standards to which they must conform should be adopted. The preparation of these definitions and standards will involve a certain amount of enquiry and technical investigation, and the Committee suggest that the Imperial Institute should be requested to undertake this work and to prepare as soon as possible draft definitions and standards for the approval of the Government of India. It seems essential that this work should be carried out in the United Kingdom, where the actual users of the resin can be consulted at each stage of the work. When the definitions and standards have been prepared they might be published, and manufacturers of lac resin might be asked to bring each of their manufactures up to or above the required standards, and to sell on a guarantee that the produce conforms with the requirements of the Government's standards for that particular form of lac resin. There are numerous precedents for such action by Government in regard to produce. The consumer who wishes to buy unadulterated lac resin will then merely have to insist on a guarantee from the seller that his purchase is up to the Government standard. The net result of this action will be the protection of the small consumer, who will have the usual legal remedy if his purchase proves to be below the guaranteed quality.

5. *Simplification of Trading in Lac Resin*

Reference has been made already to the complexity of the system of trading in lac, and especially to the number

of intermediaries who come between the actual collector of lac in India and the consumer in this country. The Committee have been informed that in certain cases German manufacturers before the war bought shellac direct from shippers in India, and thus avoided at least the intervention of brokers and traders in Germany ; and it is known that, in one case at least, a representative of German firms negotiated for the purchase of shellac direct from one of the larger factories in India. If the suggestions now made lead to the establishment in India of a few large factories in place of the existing large number of small factories, the system of trading will probably become simpler, since these factories will be in a position to sell direct to merchants in India, or possibly to put their produce direct on the London markets. It is suggested that the new Government factories now proposed might adopt the latter plan, and that an attempt should be made to co-operate, through the Local Government in Central India, with the Esociet factory, which has already adopted this procedure. It has been represented to the Committee that lac resin not sold direct from India to foreign countries should be sold or consigned to London rather than to foreign ports to ensure the existence of adequate supplies in this country in case of war, and to make London as far as possible the centre for distribution of lac resin in Europe and America, as it used to be.

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Summary

In conclusion, the Special Committee desire to place before the Government of India the following summary of suggestions :

(1) That the method of leasing concessions to collect lac should be improved and systematised, after an enquiry

in India; longer periods of leases, and a sliding scale of royalties are proposed.

(2) That greater attention be paid to improved methods of cultivation and collection of lac, and an advisory and supervisory agency should be constituted.

(3) That one or two large-scale Government factories be started, to put the manufacture on a thoroughly efficient basis and safeguard the interests of India and the Empire; lac-ware manufactures to be encouraged in India.

(4) That definite marks and grades be established, in consultation with the Imperial Institute, to ensure the maintenance of standards of purity and quality.

(5) That the system of trading be simplified, and more direct relations established between the Indian producer and the British user.

(6) * * * * *

A. Yusuf Ali (*Chairman*).
Wyndham R. Dunstan.
Stuart H. Godfrey, Lieut.-Colonel.
J. R. Dunlop Smith.
Thomas A. Henry (*Secretary*).

May 25, 1917.

II

SUPPLEMENTARY REPORT ON THE LAC TRADE OF BURMA

SINCE the Special Committee's Report on Trade in Lac was presented in May 1917, further information has been obtained which makes it desirable to supplement in certain particulars the references made in the Report (pages 14 and 15) to the lac trade of Burma.

Data are not available as to the production of lac in Burma, or as to the possible output in the districts of the province in which the lac insect occurs; but it is well known that there are large areas in the province in which lac is, or could be, collected, notably in the Pakkoku Chin Hills, and in the Southern Shan States, particularly in the Myelat Division and Yaunghwe, and in Karenni. Stebbing (*Note on the Lac Insect*) states: "There used, apparently, to be a considerable lac industry in Pegu in former days."

In addition, some stick-lac is imported into Burma from Western China, and the amount so imported has ranged from 352 cwts. in 1900–01 to 2,765 cwts. in 1916–17, the annual average quantity during the last twenty years being about 1,210 cwts. There are also small imports from Siam. The total amount of lac imported from China, the Shan States and Karenni is shown in Table I.

Comparatively little lac seems to be used in Burma itself, and the bulk of that produced and imported appears to be exported from the province, chiefly to India. Table II shows the exports of the various forms (stick-lac, seed-lac, shellac, etc.) from Burma, and their principal destinations during the last fourteen years.

It is clear from this table that the exports of lac from Burma reached their highest sustained level in the period 1903–4 to 1906–7, when the annual exports averaged

27,300 cwts. In the next ten years the average had fallen to 17,100 cwts. per annum. During this period the quantity exported fluctuated considerably, the highest point reached being in the year 1910–11, when 30,215 cwts. were exported. The *Report on the Maritime Trade and Customs Administration of Burma* for that year, commenting on this abnormal export, states : " The increase was due to the great rise in the price of shellac in London and to speculative operations on the part of local dealers, who bought up all available supplies and shipped them to the refineries at Calcutta."

The lowest exports during the period were those in the years 1911–12 and 1914–15, both of which years correspond with low prices.

An export royalty of 4*s.* 2*d.* per cwt. was imposed on all kinds of lac, irrespective of their value, with effect from January 1, 1908. This export duty was reduced in 1912–13 to 1*s.* 4*d.* per cwt. on stick-lac, and 2*s.* per cwt. on manufactured lac, but this did not arrest the decline in exports, which continued until 1915–16. The decline in exports was, therefore, not wholly due to the heavy export duty, but was largely caused by the fall in prices of all kinds of lac. Table II shows that the export trade reached a low point in 1911–12, and again in 1914–15, in both of which years the price of shellac fell to the low level of 64*s.* per cwt. in London (see Table III). In neither of these years, however, were exports from the whole of India abnormally low. Apparently, therefore, a fall in price has a greater effect in checking production of lac in Burma than in India as a whole. Table II also indicates the development of an export trade in seed-lac and shellac in the years 1910–11 to 1913–14. This was due to the opening of two lac factories in Rangoon. It is understood that one of these has ceased operations, and the export of seed-lac and shellac was on a very small scale in 1915–16 and 1916–17. The factory which has closed, it is stated, was unsuccessful probably because of the difficulty of securing the collection of sufficient raw material to keep the factory fully occupied. It has already been pointed out that the year 1914–15, when this factory appears to have closed, was one of exceptionally low prices for shellac.

The foregoing information indicates that Burma is capable of making a substantial contribution to India's output of lac, and that the decline in the amount of this contribution in recent years, down to 1914–15, has been caused mainly by the fall in the world's prices of lac, which made it difficult to pay the comparatively high prices required by the producers in Burma.

It may be possible to increase the production of lac in Burma, and reduce its cost by the introduction of a system of cultivating lac on the lines suggested on pp. 15–16 of the Committee's Report. Further, the heavy cost of labour involved in making shellac, and other manufactured forms of lac, could be saved by encouraging the export of washed seed-lac, as suggested on p. 16 of the Report.

Apart from the higher cost of production, the condition of the industry in Burma seems to be much the same as in other parts of India, though information regarding the Burmese industry is scanty.

The Committee are of opinion that as regards Burma there is no need to add to or modify the suggestions made in their original Report, which they think could all be as usefully applied in Burma as in the other and more important lac-producing areas in India.

H. ADAMSON.
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IMPERIAL INSTITUTE, S.W.7.
May 11, 1918.

APPENDIX TO THE SUPPLEMENTARY REPORT ON THE LAC TRADE OF BURMA

STATISTICAL TABLES

I. Imports of Lac into Burma by Land (Trans-frontier Trade).
II. Exports of Lac from Burma.
III. Average Prices of T.N. Orange Shellac in London, 1906–16.

TABLE I. IMPORTS[1] OF LAC INTO BURMA BY LAND (TRANS-FRONTIER TRADE)[2]

Source.	1897–1898.	1898–1899.	1899–1900.	1900–1901.	1901–1902.	1902–1903.	1903–1904.	1904–1905.	1905–1906.	1906–1907.
	Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
Western China[3]	608	531	949	352	503	1,263	925	2,382	651	1,197
[4]Northern Shan States and Kachin	892	430	352	400	577	2,846	4,570	6,930	6,477	9,536
Southern Shan States	7,740	5,327	7,876	6,231	10,082	14,883	17,035	17,810	21,211	30,527
Northern Siam	—	—	—	—	—	—	—	—	37	—
Southern Siam	—	—	—	—	—	—	—	—	—	—
Karenni	—	—	—	—	—	162	379	1,020	268	75
Total	9,240	6,288	9,177	6,983	11,162	19,154	22,909	28,142	28,644	41,335

Source.	1907–1908.	1908–1909.	1909-1910.	1910–1911.	1911–1912.	1912–1913.	1913–1914.	1914–1915.	1915–1916.	1916–1917.
	Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
Western China[3]	1,919	1,432	867	676	608	1,004	2,193	1,440	1,928	2,765
[4]Northern Shan States and Kachin	7,555	5,430	2,441	5,582	803	4,398	2,883	648	4,090	6,318
Southern Shan States	26,980	21,037	10,252	16,024	7,028	12,086	5,989	1,542	7,851	8,968
Northern Siam	—	16	—	45	—	—	138	—	—	—
Southern Siam	68	—	—	—	—	—	—	—	—	—
Karenni	43	278	55	—	—	—	—	—	—	—
Total	36,565	28,193	13,615	22,327	8,439	17,488	11,203	3,630	13,869	18,051

[1] *Figures converted from maunds taken as equal to 82 lb.*
[2] *Compiled from "Note on the Trans-frontier Trade of Burma."*
[3] *Average from Western China, 1897–98 to 1916–17 = 1,210 cwts.*
[4] *Partly through trade with China and Siam.*

TABLE II. EXPORTS OF LAC FROM BURMA[1]

	1903–04. *Cwts.*	1904–05. *Cwts.*	1905–06. *Cwts.*	1906–07. *Cwts.*	1907–08. *Cwts.*	1908–09. *Cwts.*	1909–10. *Cwts.*
Total Exports of Lac :							
From Burma[2]	29,781	24,085	26,672	28,613	18,477	21,939	15,432
,, India	235,620	240,131	274,445	269,276	362,748	380,816	554,796
Exports of Stick-lac from Burma to :							
India	29,685	23,961	26,534	26,910	13,962	21,194	15,000
United Kingdom	—	35	112	550	2,175	357	68
Other countries	60	73	15	1,153	2,340	388	338
Total	29,745	24,069	26,661	28,613	18,477	21,939	15,406
Exports of Seed-lac from Burma to :							
India	—	—	—	—	—	—	—
United Kingdom	—	—	—	—	—	—	4
Other countries	—	—	—	—	—	—	—
Total	nil	nil	nil	nil	nil	nil	4
Exports of Shellac from Burma to :							
India	—	—	—	—	—	—	—
United Kingdom	—	—	—	—	—	—	—
Other countries	—	—	—	—	—	—	—
Total	nil	nil	nil	nil	nil	nil	nil
Exports of other Lac from Burma to :							
India	36	16	11	—	—	—	22
United Kingdom	—	—	—	—	—	—	—
Other countries	—	—	—	—	—	—	—
Total	36	16	11	nil	nil	nil	22

[1] *Compiled from the "Annual Statement of the Sea-borne Trade and Navigation of Burma with Foreign Countries and Indian Ports."*
[2] *Excluding trade between ports in Burma.*

TABLE II. EXPORTS OF LAC FROM BURMA (*continued*)

	1910–11. *Cwts.*	1911–12. *Cwts.*	1912–13. *Cwts.*	1913–14. *Cwts.*	1914–15. *Cwts.*	1915–16. *Cwts.*	1916–17. *Cwts.*
Total Exports of Lac :							
From Burma [1]	30,215	7,875	18,426	10,403	3,798	19,437	24,985
,, India	421,628	428,006	428,163	339,161	366,692	417,320	381,349
Exports of Stick-lac from Burma to :							
India	27,192	1,781	9,441	6,330	2,962	19,344	24,338
United Kingdom	1	8	—	—	—	—	—
Other countries	—	—	199	1	16	19	—
Total	27,193	1,789	9,640	6,331	2,978	19,363	24,338
Exports of Seed-lac from Burma to :							
India	—	—	—	—	—	—	—
United Kingdom	284	26	—	—	—	37	—
Other countries	1,324 [2]	4,415 [2]	5,903 [2]	3,527 [2]	110	4	—
Total	1,608	4,441	5,903	3,527	110	41	nil
Exports of Shellac from Burma to :							
India	—	—	—	—	—	—	—
United Kingdom	198	563	—	—	—	—	—
Other countries	119	495 [2]	1,466 [2]	378 [2]	62 [2]	15	37
Total	317	1,058	1,466	378	62	15	37
Exports of other Lac from Burma to :							
India	713	3	1,351	5	—	—	573
United Kingdom	348	579	—	—	—	11	37
Other countries	36	5	66	162	648	7	—
Total	1,097	587	1,417	167	648	18	610

[1] *Excluding trade between ports in Burma.*

[2] *Chiefly to United States.*

TABLE III. AVERAGE PRICES OF T.N. ORANGE SHELLAC IN LONDON, 1906–16

	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.
Shillings per cwt.	201	191	107	70	75	69	64	86	66	64	104

III

REPORT ON INDIAN TURPENTINE AND ROSIN

An Interim Report on Indian Turpentine and Rosin, dated June 10, 1918, was made to the India Office by the Special Committee, in which it was suggested that the Government of India should furnish certain information which was necessary for a complete consideration of the subject (see Appendix II). In accordance with this suggestion the Government of India have had prepared, and have forwarded for the information of the Special Committee, Reports on the Resin Industry of India by A. J. Gibson, Deputy Conservator of Forests, Resin Forest Division, Punjab, and W. F. Perree, Conservator of Forests, Utilisation Circle, United Provinces; these are printed as Appendices III and IV. A copy of the Annual Progress Report on the Resin Industry in the Kumaun Circle, United Provinces, for the financial year 1917–18, was also received, together with covering letters from the Officiating Secretary to the Government of India, the Officiating Revenue Secretary to the Government of the Punjab and the Secretary to Government of the United Provinces. The information contained in these Reports has been carefully considered by the Special Committee and has been utilised in preparing the present Report, which includes the information contained in their Interim Report.

Valuable information was also supplied by Sir S. Eardley-Wilmot, K.C.I.E., formerly Inspector-General of Forests to the Government of India, Mr. J. C. Nicholson, of Messrs. Jenson and Nicholson, Ltd., Messrs. The Rosin and Turpentine Import Co., Ltd., and Messrs. R. Ingham Clark & Co., Ltd.

The terms oleo-resin, turpentine and rosin, which will be used throughout the report, may require some explanation to those not familiar with the details of this industry. The term oleo-resin is used to indicate the viscid substance which exudes when incisions are made in the bark of certain species of pine. On steam distillation this oleo-resin separates into two portions, the volatile oil, which is known as turpentine, and the solid material which is familiar as ordinary rosin. There are therefore two distinct branches of the industry: the first, the incision or "tapping" of the pines and the collection of the exuded oleo-resin, being carried on throughout the forest, and the second, *i.e.* the distillation of the oleo-rosin to produce the commercial articles turpentine and rosin, being undertaken at some convenient centre usually in or near the forests worked.

Indian turpentine and rosin are in a somewhat different position from the other Indian products, which form the subjects of the Special Committees' enquiries, since export trade in turpentine and rosin of Indian origin has scarcely begun. Such small quantities as have reached this country are merely experimental consignments.

Sources of Supply of Turpentine and Rosin to the United Kingdom

The United Kingdom has hitherto obtained its supplies of turpentine from foreign countries, chiefly the United States, France and Russia, and its rosin in recent years from the United States, France, Spain and Portugal (see Table I, appended to this Report).

Although there are some new sources of supply, such as Spain, Algeria, Greece, etc., the price of turpentine has risen steadily in the United Kingdom in recent years.

A number of substitutes for turpentine have been successfully introduced, and their use is constantly extending, especially in the paint, enamel and varnish industries; but for the introduction of these substitutes the rise in price would have been even more rapid.

Substitutes for rosin have not been introduced to the same extent as for turpentine. On the contrary, a number

of new uses for rosin have been found, and the demand for this material is steadily increasing.

The state of things briefly outlined above accounts for the interest shown in recent years by British firms in the possibility of obtaining supplies of turpentine and rosin from India, which is at present the only part of the British Empire producing these raw materials in quantity.

Production of Turpentine and Rosin in India

Turpentine and rosin are at present being produced in the United Provinces and Punjab. In the former province distillation was carried on at a factory at Bhowali, in the Naini Tal Division, but a new factory has since been erected at Bareilly. The Punjab oleo-resin is distilled at a factory at Jalloo.

According to information supplied by Mr. W. F. Perree, the capacity of the new factory at Bareilly will be 120,000 maunds (88,000 cwts.) of crude oleo-resin, yielding 80,000 maunds (59,000 cwts.) of rosin and 240,000 gallons of turpentine, and it was hoped that this output would be reached in 1919.[1] By the installation of another still a further 30,000 maunds (22,000 cwts.) of crude oleo-resin could be dealt with, making a total of 150,000 maunds (110,000 cwts.), which Mr. Perree regards as the maximum that can be safely dealt with, with the transport facilities available in the forests now being worked. The factory can be extended when necessary to a capacity of at least 300,000 maunds (220,000 cwts.) of crude oleo-resin.

The present output from the Punjab factory is about 25,700 maunds (19,000 cwts.) of rosin and 70,000 gallons of turpentine, which represents almost the maximum capacity of the factory. The maximum possible output under present conditions from the Government factories, which are the only ones existing in India, may therefore be taken at about 100,000 maunds (73,000 cwts.) of rosin and 300,000 gallons of turpentine per annum.

[1] The completion of the Bareilly factory was delayed, owing mainly to the difficulty of obtaining machinery, and operations were not commenced until early in 1920.

The quantities of rosin and turpentine imported and produced in India during the last seven years for which figures are available are shown in the following table; detailed figures of the imports of rosin and turpentine into India during recent years are given in Table II appended to this report.

Rosin

Year.	Imports.	Production of Indian Government Factories.			Grand Total.
		Bhowali (U.P.)	Jalloo (Punjab).	Total.	
	Cwts.[1]	*Cwts.*[2]	*Cwts.*[2]	*Cwts.*	*Cwts.*
1912–13	61,017	15,141	5,403	20,544	81,561
1913–14	44,788	16,916	3,236	20,152	64,940
1914–15	24,323	23,055	1,823	24,878	49,201
1915–16	30,765	25,700	8,940	34,640	65,405
1916–17	18,368	32,002	11,729	43,731	62,099
1917–18	31,496	32,272	12,068	44,339	75,835
1918–19	6,585	33,035	13,674	46,709	53,294
1919–20	13,906	31,183	18,894	50,077	63,983
		Turpentine			
	Galls.[3]	*Galls.*[4]	*Galls.*[4]	*Galls.*	*Galls.*
1912–13	270,127	47,308	12,941	60,249	330,376
1913–14	208,650	50,278	8,525	58,803	267,453
1914–15	153,244	70,713	7,776	78,489	231,733
1915–16	93,860	80,390	31,445	111,835	205,695
1916–17	85,904	84,565	41,098	125,663	211,567
1917–18	52,871	93,970	46,709	140,679	193,540
1918–19	70,902	96,251	52,701	148,952	219,854
1919–20	111,917	81,448	70,974	152,422	264,339

[1] *From official Trade Returns.*

[2] *Based on figures in Forest Department Reports, maunds being converted into cwts. at the rate of* 1 *maund* = 82⅔ *lb.*

[3] *Based on official Trade Returns, cwts. being converted into gallons at the rate of* 1 *cwt.* = 13 *gallons.*

[4] *From Forest Department Reports.*

NOTE.—*The figures for production are for the forest years ending June* 30, *and those for imports for the financial year ending March* 31.

It is clear from this table that Indian production of turpentine and rosin is, on the whole, overtaking the present Indian demands. The recent annual demand for rosin in India may be taken to be about 90,000 maunds (66,000 cwts.). During the last two years the total mean annual output from the Government factories has been 65,000 maunds (48,000 cwts.), practically all of which was disposed of in India. As already stated, it was hoped that the Bareilly factory would be in a position to supply 80,000 maunds (59,000 cwts.) of rosin during 1919, but

the Conservator in charge of resin operations considers that, as the rosin is light amber in colour, it could not entirely replace the red American rosin (a dark-coloured rosin being preferred in India), and it is probable that not more than 50,000 maunds (37,000 cwts.) can be disposed of in India, leaving 30,000 maunds (22,000 cwts.) for export overseas.

The highest consumption of turpentine in India so far has been 330,000 gallons in 1912–13, the average during the eight years ending 1919–20 being about 240,000 gallons. The total Indian output in 1919–20 was 152,000 gallons, but it was anticipated that when the Bareilly factory is working at its full capacity, *i.e.* producing 240,000 gallons of turpentine yearly, the demand for turpentine in India will be met by supplies produced within the country.

A further addition to the Indian supplies of turpentine may be found in the future in the turpentine of *Boswellia serrata*, which has been shown by investigations carried out at the Imperial Institute and in India to be suitable for use as a substitute for ordinary turpentine in paint and varnish making. A full account of the investigation of Boswellia turpentine is given in the *Bulletin of the Imperial Institute*, vol. xvii (1919), pp. 159–177.

External Markets for Indian Turpentine and Rosin

The Forest Administration Reports, and the various special reports dealing with turpentine and rosin which have been issued by the Indian Forest Department show that the question of exporting turpentine and rosin from India to the United Kingdom has been carefully and sympathetically considered, but that the conclusion has been reached that when Indian demands have been met, a market for the surplus should be sought chiefly in Australasia and the Far East, probably because it is thought that the prices obtainable for the Indian produce in the United Kingdom would not be remunerative, owing chiefly to the high cost of transport. The following statements on this point may be given as exemplifying the position :

"The better grades of turpentine oil are so greatly in demand in this country (India) that there seems to be no probability for a long time to come of exporting Indian turpentine oils to the United Kingdom." (Puran Singh, *Forest Bulletin*, No. 24, 1913, p. 11.)

"There is no possibility of exports to England or Europe, the natural outlet for any balance, after meeting Indian requirements, being to Australia, New Zealand, Java, etc." (E. A. Smythies, I.F.S., *Forest Bulletin*, No. 25, 1914, p. 13.)

"At present the resin (oleo-resin) industry is practically in the position of having to retard or accelerate its expansion with direct reference to the speed with which the remainder of the Indian market can be secured, and outside markets, such as Java, China, etc., developed. It is here that closer co-operation with the trade interests of India is necessary, and more active measures have to be adopted to advertise Indian rosin and turpentine." (R. S. Troup, *The Work of the Forest Department in India*, 1917, p. 48.)

"In the present position of shipping, export to England is scarcely possible, and the demand for rosin and turpentine in Europe is more likely to be met from the large stocks of naval stores known to be held in America. The Indian rosin industry can therefore only be expected to relieve the English market by satisfying the demand in India and adjacent countries, and adding to the total world's supply." (W. F. Perree in his report forwarded to the Special Committee by the India Office—see Appendix IV.)

On the other hand a number of British firms of varnish and paint manufacturers had before the war obtained experimental consignments of Indian turpentine for trial, and had satisfied themselves that, in spite of the difference in composition between it and the turpentine obtained from France, the United States and elsewhere, as established by numerous investigations made at the Imperial Institute and at the Forest Research Institute at Dehra Dun, Indian turpentine is of good quality and quite suitable for general use. Indeed the representative of one firm, who gave evidence before the Committee, stated that for certain purposes it was superior to French and American turpentines. The Committee's enquiries show that a number of British firms are much interested in the question of securing supplies of turpentine and rosin from India, and that if Indian turpentine could be placed on

the British market it would probably fetch prices but little below those of French and American turpentine.

Development of Turpentine and Rosin Production in India

1. *Extent of Forests*

The annual imports of turpentine and rosin into the United Kingdom during the six years 1912 to 1917 have averaged 440,000 gallons and 1,600,000 cwts. respectively. These amounts are far in excess of the prospective Indian production as indicated on page 3 of this report.

If, therefore, India is to be in a position to make any noteworthy contribution to the supply of turpentine and rosin required by the United Kingdom and other parts of the Empire in the future, production on a much enhanced scale will have to be undertaken, and it becomes of interest to ascertain what quantities of these products India could supply.

Mr. A. J. Gibson, in his report (see Appendix III), considers that tapping could at once be extended in the Punjab and North-West Frontier Provinces to an area five times that now being worked, and capable of yielding 80,000 maunds (59,000 cwts.) of rosin and 200,000 gallons of turpentine, and that within ten years the Government forests in those provinces and the forests in certain native States should yield annually 150,000 maunds (110,000 cwts.) of rosin and 400,000 gallons of turpentine. With proper development of transport facilities these figures can probably be largely exceeded.

Mr. Perree estimates (see Appendix IV) that the Chir (*Pinus longifolia*, Roxb.) forests of Kumaun, Chakrata and the leased territories of Tehri-Garhwal, together with the adjoining forest of Tehri-Garhwal, should give an annual yield of about 650,000 maunds (477,000 cwts.) of crude oleo-resin (equivalent to about 432,000 maunds (327,000 cwts.) of rosin and 1,300,000 gallons of turpentine).

In addition to the species of pine (*Pinus longifolia*, Roxb.) at present being tapped, four others are indigenous to India, of which *P. excelsa*, Wall., of the Himalayas, and *P. Khasya*, Royle, of Assam and Burma, and possibly also *P. Merkusii*, Jungh. and de Vriese, of Burma,

are likely to be of value in the future as sources of turpentine and rosin. A full account of the results of the examination at the Imperial Institute of the turpentine and rosin derived from *P. excelsa* and *P. Khasya*, as well as *P. longifolia*, is given in the Memorandum published with this Report. Mr. Gibson estimates that the annual yield from all species of pine in India should ultimately amount to at least 600,000 maunds (440,000 cwts.) of rosin and 1,600,000 gallons of turpentine, which should then leave an appreciable supply for export.

The development of the Indian resin industry depends, however, almost entirely on the provision of efficient transport facilities in the forests. Some idea of the importance to be attached to the question of transport may be gained from the facts that the tapping operations for supply of oleo-resin to the Bhowali distillery extended over an area of not less than 2,000 square miles, of which not more than 400 square miles are pine forest (E. A. Smythies, I.F.S., *Forest Bulletin*, No. 26, 1914, p. 5).

According to Mr. Perree, forests which are served by a good cart road can profitably be exploited to a distance of 100 miles from rail-head, but in the absence of cart roads they cannot be worked to a much greater distance than twenty-five miles. At present the pine forests in the United Provinces are served by only one cart road.

In view of the present restricted transport facilities it seems clear that a considerable proportion of the pine forests in India must await development until better means of transport become available, and it is possible that much of the area will for many years be too inaccessible to be worked.

2. *Mode and Cost of Working*

A second important matter, which arises in connection with the consideration of any proposals for the extended production of turpentine and rosin in India, is that of the mode of exploitation, by Departmental Agency or private enterprise. So far all the Indian pine forests utilised for turpentine and rosin production have been worked departmentally.

The policy of the Government of India regarding forest

concessions is outlined, as follows, in the *Quinquennial Review of Forest Administration in British India for the Period* 1909–10 to 1913–14, p. 7, paragraph 14 :

" *Agency of Extraction.*—The question of the agency by which forest produce should be extracted has given rise to considerable discussion in the past, and although certain general principles may be laid down, the form of agency most suitable to any particular province or area must necessarily depend upon local conditions.

" In forest administration the object in view is twofold, first to conserve and improve the forests, and this is the first concern of the trained staff, and secondly to secure to the tax-payer the greatest immediate benefit from their commercial working. To obtain the best commercial results departmental or private agency should be employed as circumstances dictate, and, provided always that Government receives a full share of the profits earned, private agency should be freely employed. But when this is done the term of the contract should on the one hand be sufficiently long to enable the initial outlay to be recovered, while on the other hand provision should invariably be made for a revision of the rates of royalty at stated intervals so that Government may not be deprived of its fair share of any rise in prices which may take place. Should it be found impossible to employ private agency on these terms, departmental working should be adopted, and if this cannot be undertaken by the trained staff without prejudice to its work of conservation and improvement there seems to be no reason why a separate staff specially trained in commercial exploitation should not be employed. At times, indeed, departmental working is essential, as, for instance, in the extraction of little known timbers or other products for which it is desired to create a market, when for any reason the system of extraction by purchasers breaks down, or when it becomes necessary to prevent trade manipulation or the creation of a monopoly.

" Having regard to these general principles, which, in their opinion, should govern the decision as to the form of agency to be employed, the Government of India are inclined to believe that in some parts of India departmental agency might perhaps be profitably employed more extensively than at present."

With regard to the special case of concessions of pine forests no separate announcement of policy seems to have been made, but probably the following quotation

from a report by Mr. A. Rodger, Forest Economist, Dehra Dun, supplied to the Imperial Institute in September 1911, may be taken as indicating the considerations which have had special weight in determining the Government of India to pursue the present plan of developing the pine forests by State agency :

" In the United Provinces very strong reasons are advanced against leasing the forests to firms or contractors who would tap the trees and collect the resin (oleo-resin). This trade is in a peculiar position, as compared with most forest industries, the disadvantages of handing over the work to private firms or individuals being chiefly :

" (*a*) The cost of supervision is heavy, and the work is at present done by forest subordinates as part of their duties.

" (*b*) Fire must at all hazards be kept out, and no agency is so well fitted for this as the Forest Department.

" (*c*) An unexpected accident, such as a severe fire, would oblige the forests to be closed to tapping and would entail great loss to lessees.

" (*d*) Tapping cannot be done properly in such a way as to safeguard the future interests of the trees and the interests of the local population, unless supervised by Government officers.

Lessees would be apt to use all means to increase the flow of resin, regardless of the future.

" These are the main reasons advanced by the local Government and Conservators of the United Provinces against leasing the forests, and it is probable that they would also be valid in the Punjab, though the Conservator there does not at present desire to express an opinion.

" Further experience in both provinces and in Burma will doubtless leave no doubt on this point which may at present be left until the factories are all in full working order."

Similarly E. A. Smythies, I.F.S., in *Forest Bulletin*, No. 26, 1914, p. 12, says :

" The mere fact that the Forest Department have control of all the available pine forests in Kumaun (in

fact of practically all the exploitable pine forests in the Himalayas [1]) makes the resin (oleo-resin) industry in India essentially a Department monopoly. This puts the greater responsibility on the Department to develop the industry on sound commercial lines to its greatest possible extent in the most satisfactory manner."

Mr. Gibson and Mr. Perree in their reports also support Mr. Rodger's views quoted above. Mr. Perree states that " the most important part of the industry lies in the forest work. Experience has clearly proved that this work cannot be entrusted to contractors without risk of serious injury to the trees and loss of output. The collection of resin is largely a result of a good understanding between the Forest Department and the local people. The protection of the forests depends upon the continuance of these good relations, and there is grave risk that they would be disturbed by the introduction of private enterprise."

Mr. Gibson, however, considers that there seems little or no objection to Government handing over the crude oleo-resin at rail-head at a fixed royalty per maund to private firms, who would carry out the actual distillation and disposal of the manufactured products.

Closely connected with this question of the mode of working the forests is that of the cost of production of turpentine and rosin in India.

Mr. Gibson estimated that the total cost of the collection, carriage, distillation, etc., of a maund ($82\frac{2}{7}$ lb.) of crude oleo-resin in the Punjab is Rs.10, whilst the corresponding figure in the case of the United Provinces, calculated from the particulars given in the Annual Progress Report on the Resin Industry in Kumaun, 1917–18, is Rs.9–5–2. Both estimates are higher than in pre-war times, owing to the high prices of labour and materials due to war conditions, but they may be taken to represent the present costs, as it is unlikely that the price of labour and materials will fall appreciably.

Mr. Perree estimates that the cost of rosin and turpentine from the United Provinces, placed on board ship at Indian ports, based on the prices prevailing at the end

[1] Apparently British India only is referred to here.

of 1918, would be: rosin, Rs.16 per maund (43*s.* per cwt., taking 1 R. = 2*s.*); turpentine, No. 1 grade, Rs.5 per gallon (£5 10*s.* per cwt.), No. 2 grade, Rs.4 per gallon (£4 8*s.* per cwt.), No. 3 grade, Rs.3 per gallon (£3 6*s.* per cwt.). The controlled price of American rosin in London in 1918 ranged from £55 to £57 10*s.* per ton, according to grade, whilst the maximum controlled price of turpentine was 120*s.* per cwt. Indian rosin should realise about the same price as the lower grades of American rosin, and Indian turpentine slightly less than American turpentine, which, at the prices ruling in London in 1918, seems to leave an ample margin for freight and profit. At the present time (May 1920) the price of American rosin in London is from 55*s.* to 65*s.* per cwt. according to grade, and that of turpentine 200*s.* per cwt.

It would therefore appear that the United Kingdom is well worth consideration as a market for the exportable surplus, both of turpentine and rosin.

Conclusions

Although at the moment there may be large supplies of rosin and turpentine in the United States owing to the shortage of shipping during the past few years, there is evidence that the area of pine forests in the United States is gradually being reduced and that production is declining. Further, the cost of production there has risen, owing largely to the increased cost of labour. The price of American rosin and turpentine is therefore likely to remain high for some time, and there will consequently be a good market for the Indian products at high prices.

The Special Committee consider that every effort should be made to increase the Indian production, and beg to make the following recommendations:

1. Transport facilities should be improved in order that the total area tapped may be increased, e.g. by the construction of forest tramways, cart roads, bridle paths and rope-ways, and by the introduction of tank cars for the conveyance of the crude oleo-resin.

2. In view of the facts placed before the Committee it would appear that the forest work, viz. the tapping of

the trees and collection of the oleo-resin, must for the present be conducted by the Forest Department. It is, however, desirable that before long the question of transferring the distillation of the oleo-resin, and the marketing of the products to private enterprise should be carefully considered.

3. Experiments should be continued with a view to the improvement of tapping and methods of collection, so as to increase the out-turn and quality of the crude oleo-resin. If the extraction is conducted entirely by the Forest Department, the staff should be enlarged so that officers will be available to give their whole time to the experimental work.

4. In view of the favourable opinion expressed by British manufacturers, as soon as opportunity offers the Government of India should arrange that a substantial consignment of the various grades of Indian turpentine and rosin produced at the Bareilly factory should be sent to London for sale, in order to ascertain precisely the prices which these materials as at present produced will command in Europe.

5. Samples of the various grades of Indian turpentine and rosin should be kept at the Imperial Institute, and renewed from time to time by the Forest Department, so that small supplies could be furnished as required to manufacturers and others desiring to make technical trials of these materials.

H. ADAMSON.
A. BIGLAND.
F. W. F. CLARK.
W. R. DUNSTAN.
S. H. GODFREY.
J. R. DUNLOP SMITH.

T. A. HENRY (*Secretary*),

IMPERIAL INSTITUTE, S.W.7.,
May 1920.

APPENDIX I

STATISTICS

TABLE I. TRADE IN ROSIN AND TURPENTINE IN THE UNITED KINGDOM

IMPORTS OF ROSIN

		1913.	1914.	1915.	1916.	1917.	1918.	1919.
Total quantity	Cwts.	1,758,067	1,548,184	2,071,963	2,001,815	1,726,558	752,423	1,780,425
Total value	£	1,120,652	822,093	1,200,483	1,888,887	2,466,134	1,808,608	3,819,112
From :		*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
British countries [1]		27,035	563	12,523	—	4	1,286	29,575
United States		1,322,026	1,072,228	1,082,312	1,514,901	1,302,276	365,496	1,115,161
France		193,440	323,537	757,129	291,604	297,284	316,124	423,548
Belgium		55,268	24,682	—	—	—	—	—
Portugal		29,002	19,224	48,044	50,156	58,865	49,985	70,848
Spain		91,163	84,334	165,452	140,854	68,129	17,574	121,484
Other foreign countries		40,133	23,516	9,503	4,300	—	1,958	19,809

[1] *These imports from British countries are believed to be chiefly American rosin imported via Canada.*

RE-EXPORTS OF ROSIN

		1913.	1914.	1915.	1916.	1917.	1918.	1919.
Total quantity	Cwts.	80,088	167,335	497,322	350,160	40,121	699	29,258
Total value	£	55,031	89,374	295,544	334,736	46,021	1,868	69,892
To :		*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
Union of South Africa		7,401	6,411	17,896	20,073	1,693	306	4,550
India		7,611	11,442	16,545	11,992	5,233	—	1,817
Australia		2,717	20,475	51,260	8,432	313	—	1,702
New Zealand		2,475	3,384	11,281	9,608	4	—	1,521
Canada		8,364	10,093	5,091	3,569	—	—	—
Other British Possessions		373	1,039	2,015	1,336	649	—	708
Russia		2,297	16,682	130,771	135,744	18,839	—	10,747
Sweden		386	13,297	28,650	52,324	10	—	343
Norway		4	12,715	24,350	9,314	4,000	—	—
Denmark and Faroe Islands		—	960	20,754	11,770	1,762	393	1,350
Netherlands		1,252	17,594	38,841	27,483	6,792	—	3,163
Java		3	2,022	91,435	29,730	104	—	631
Belgium		6,509	3,564	—	—	—	—	—
Japan		8,648	427	—	12,893	—	—	—
United States		4,891	15,636	37,219	4,850	—	—	—
Argentine Republic		21,295	26,899	16,201	6,618	305	—	48
Other foreign countries		5,862	4,695	5,013	4,424	417	—	2,678

Imports of Turpentine

		1913.	1914.	1915.	1916.	1917.	1918.	1919.
Total quantity	*Cwts.*	560,330	348,206	529,517	430,780	221,192	63,320	455,839
Total value	£	768,800	542,205	903,381	903,384	620,747	326,197	1,940,001
From		*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
British Possessions		—	—	—	—	—	—	6
United States		476,400	294,509	418,050	368,575	202,633	20,218	381,132
France		33,656	19,491	40,506	5,229	180	24,275	36,688
Russia		32,648	21,006	3,899	—	—	—	613
Germany		5,293	2,914	—	—	—	—	—
Other foreign countries		12,333	10,286	67,062	56,976	18,379	18,827	37,400

Re-Exports of Turpentine

		1913.	1914.	1915.	1916.	1917.	1918.	1919.
Total quantity	*Cwts.*	23,140	24,760	50,858	49,114	22,102	1,577	28,838
Total value	£	36,462	40,061	93,568	115,060	62,471	8,571	133,497
To		*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
British India		2,947	2,425	1,785	2,044	1,848	624	1,620
Australia		4,540	3,309	2,680	431	4	—	20
New Zealand		1,504	1,112	624	1,008	425	—	4
Other British Possessions		2,514	1,640	1,879	2,988	1,517	822	1,470
Russia		4,963	3,995	3,681	3,058	1,920	—	179
Sweden		1	170	1,503	2,907	34	—	321
Norway		119	616	1,446	319	—	10	—
Denmark and Faroe Islands		—	1,687	3,589	3,666	172	—	2,511
Germany		1,206	2,178	—	—	—	—	—
Netherlands		7	5,471	31,332	30,386	14,486	—	6,214
Belgium		2,476	66	—	—	—	—	13,933
Other foreign countries		2,863	2,091	2,339	2,307	1,696	121	2,566

TABLE II

Imports of Rosin into India

	1912-13.	1913-14.	1914-15.	1915-16.	1916-17.	1917-18.	1918-19.	1919-20.
Total quantity . . *Cwts.*	61,017	44,788	24,323	36,765	15,368	31,496	6,585	13,906
Total value . . . £	60,293	33,150	15,466	22,538	21,662	46,540	10,461	25,793
From :	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	
United Kingdom . . .	12,287	13,988	10,162	16,447	13,096	2,076	920	Figures not available.
Other British countries .	65	38	33	58	46	52	296	
United States . . .	45,999	25,964	13,811	14,249	4,749	12,533	2,362	
Belgium	1,185	2,834	43	—	—	—	—	
Germany	1,402	1,918	274	—	—	—	—	
Austria-Hungary . . .	34	—	—	—	—	—	—	
Japan	—	—	—	—	467	16,735	1,990	
Other foreign countries .	—	26	—	11	—	—	1,017	

Imports of Turpentine Oil into India

	1912-13.	1913-14.	1914-15.	1915-16.	1916-17.	1917-18.	1918-19.	1919-20.
Total quantity . . *Cwts.*	20,779	16,050	11,758	7,230	6,608	4,067	5,454	8,609
Total value . . . £	30,539	28,319	22,531	14,175	17,407	14,200	21,490	34,736
From :	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	
United Kingdom . . .	18,818	13,485	8,962	7,034	6,309	3,266	786	Figures not available.
Other British countries .	379	1	2	27	2	131	143	
United States . . .	1,559	2,488	2,790	136	294	670	3,309	
Germany	21	74	—	—	—	—	—	
Other foreign countries .	2	2	34	21	3	—	1,216[1]	

[1] *Including 957 cwts. from Dutch Borneo and 210 cwts. from the Philippines.*

APPENDIX II

POINTS ON WHICH INFORMATION WAS REQUESTED FROM THE GOVERNMENT OF INDIA IN INTERIM REPORT OF THE COMMITTEE

1. Estimated total areas of pine forests in British India, and, if possible, of similar areas in the Indian States, which could be worked under present transport conditions, and information as to any additional transport facilities required in other cases.

2. Areas of pine forests, if any, which the Government of India would be prepared to lease to firms for working, and the conditions under which leases would be granted. Similar information which may be available as to any areas in Indian States for which leases might be granted.

3. If no leases can be granted for private enterprise, would the Government of India be prepared to make any other arrangement with firms, to co-operate in the development of turpentine production in India ?

4. A detailed statement of the cost of production of turpentine and rosin at the Bhowali and Jallo factories. This estimate should give details of the cost of supervision, management and labour, both as regards the collection of the oleo-resin and its distillation and sale. An estimate of the cost of turpentine and rosin f.o.b. Indian ports for export would also be useful.

APPENDIX III

The following Memorandum on The Prospects and Possibilities of Expansion of the Oleo-Resin Industry in India and Burma, by Mr. A. J. Gibson, Deputy Conservator of Forests, Punjab, has been supplied to the Committee by the Government of India.

Some Factors and Figures given for Reference

The standard maund = 82$\frac{2}{7}$ lb.
27·22 maunds = 1 ton.
Jallo rosin barrel = 5·67 maunds gross and 5·1 maunds net.
Tare of barrel = 0·57 maunds, or, say, 10 per cent.
Specific gravity of *Pinus longifolia* turpentine = 0·865.
1 cwt. turpentine = 13 gallons naked.
1 cwt. turpentine = 11 gallons packed in 6$\frac{3}{4}$ lb. drums.
£1 = Rs.15.
1 maund crude resin *yields 70 per cent. by weight of rosin and two gallons of turpentine.*

1. The extent of the industry in India (United Provinces and

Punjab) is shown by the following figures for the forest year 1917–18 (to 30th June, 1918).

Area of forests tapped . . .	92,493 *acres.*
Number of blazes or cups . .	2,485,222
Rosin manufactured . . .	58,500 *maunds.*
Turpentine manufactured . .	141,407 *gallons.*

2. The average imports and local production of rosin and turpentine for ten years, compared with the figures for 1917–18 (financial), are set out in the following table :

Financial Year.	Rosin (*Maunds*).			Turpentine (*Gallons*).		
	Imports.	Indian Output.	Total.	Imports.	Indian Output.	Total.
1907–08 to 1916–17.	67,258	24,412	91,670	188,921	54,363	243,284
In 1917–18.	44,094	60,938	105,032	140,772	136,052	276,824

These figures show that Indian manufacture is having a steady effect on imports, but that a considerable amount of expansion is still necessary to fully secure the Indian market.

As stated above, under 100,000 acres of *Pinus longifolia* forest are being tapped at present in India to secure these results. At a rough estimate, four times that area is immediately available. This estimate is based on the figures of area given at page 2 of Mr. R. S. Troup's Memoir on *Pinus longifolia* (vol. i, part i, Sylvicultural Series, Indian Forest Memoirs—Superintendent Government Printing, Calcutta, 1916) and on the writer's own calculations on the subject.

3. In the Punjab for the forest year ending 30th June, 1918, 14,621 acres of forest only were tapped to yield 16,246 maunds of rosin and 46,709 gallons of turpentine.

In the Punjab and North-West Frontier Province, tapping operations could be extended at once to :

15,000 acres in Hazara division—North-West Frontier Province.
30,000 acres in Rawalpindi division.
30,000 acres in Kangra division.

Total : 75,000 acres,

or, say, five times the area at present being tapped, yielding some 80,000 maunds of rosin and 200,000 gallons of turpentine. To this estimate must be added tappable areas in Jammu and Kashmir State, Chamba State, the Civil forests of Shahpur-Kandi, Patiala, Bhagat and Bilaspur States. If the easily accessible " guzaras " or village forests of Rawalpindi and Hazara be added, the total would be largely increased.

Assuming labour difficulties are capable of solution, there is no

reason why the Punjab Forest Department forests and those of the North-West Frontier Province, working in co-operation with the native States, etc., mentioned, should not give within ten years an annual yield of 150,000 maunds of rosin and some 400,000 gallons of turpentine.

With proper development of roads and possibly of light railways (as for instance in the Kangra Valley), these figures can probably be largely exceeded, as the area of *Pinus longifolia* in India is over 2,000,000 acres.

4. *Pinus longifolia* is only one of several tappable pines in India and Burma. For further details, see Puran Singh's *Forest Bulletin*, No. 24, "Notes on Turpentine of *Pinus Khasya*, *Pinus Merkusii* and *Pinus excelsa*" (Superintendent of Government Printing, India, 1913). To these pines must be added the *Pinus Gerardiana* of the frontier. It is difficult to estimate the yield, but I am inclined to put the total yield of rosin and turpentine from India and Burma in the next ten years, with energetic, business-like expansion, at 300,000 maunds of rosin and 800,000 gallons of turpentine a year.

Ultimately these amounts can be at least doubled. That is, India and Burma can some day contribute at least 430,000 cwts. of rosin and 120,000 cwts. of turpentine for its own and the Empire's uses.

5. The question as to the best outlet for these products depends largely on a comparison, of costs of production and freight to markets or ports, with large producing countries such as America and France. The figures of cost in the Imperial Institute report, taken from Forest Administration Reports of the United Provinces and Punjab, are based on disconnected and arbitrarily fixed twelve-month calculations, and as such are not very accurate, as of necessity they show large fluctuations. Up-to-date figures are given in Mr. Perree's special annual progress report on the Resin Industry in the Kumaun circle, United Provinces, for the financial year 1917–18 (Superintendent Government Press, United Provinces, Allahabad, 1918), while the following are figures for the Punjab worked out by the writer:

COSTS ON THE COLLECTION, CARRIAGE, DISTILLATION, AND OTHER EXPENDITURE OF A MAUND OF RESIN, NET, PUNJAB

I. Forest Expenditure

Daily labour on collection	Rs.1. 2.0
Packing in kerosene tins (used 3–4 times)	0.12.0
Carriage to factory	0.14.0
Local supervision (permanent establishment and temporary establishment)	0. 8.0
Share of setting up new crops (spread over 5 years)	0. 4.0
Replacement of tapping tools, pots, etc.	0. 2.0
Share of circle administration charges and distributive "B" administration heads	0. 6.0
	Rs.4. 0.0

II. MANUFACTURING COSTS

Daily labour	Rs.0. 1.6
Mill stores and lighting stores	0. 4.0
Firewood, including full royalty (*i.e.* at market value)	0. 8.6
Packing rosin and turpentine	1.14.0
Carriage of manufactured products to market (mainly seaports)	1.11.0
Commission to agents	0. 8.0
Local supervision (permanent establishment and temporary establishment)	0. 1.0
Share of circle administrative charges and distributive "B" heads	0. 6.0
Replacements and renewals of plant, etc.	0. 3.0
Depreciation and interest	0. 7.0
	Rs.6. 0.0

These are war prices and are 25 per cent. to 35 per cent. in excess of pre-war prices. The costs of delivery of the goods at Karachi would also be cheaper, as it is the nearest port to the Punjab, whereas the above figures show average cost of delivery to places including Calcutta, Bombay and Madras.

Average prices for rosin and turpentine f.o.r. Jallo for the year ending on 30th June, 1918, were :

Rosin	Rs.13.15.4 per maund net.
Turpentine, quality I	3.14.7 per gallon.
Turpentine, quality II	3. 7.9 per gallon.

The Imperial Institute wishes to know the cost of Indian rosin f.o.b. The above costs have to be distributed. The basis of distribution of costs is the proportion of gross revenue per crude maund of resin, realised respectively by the rosin and the turpentine.

At current rates these figures are Rs.20, Rs.12 and Rs.8 respectively. On this basis the cost of Punjab rosin f.o.b. Karachi will not exceed Rs.9 per maund net, say 16*s.* 4*d.* per cwt. net, and of turpentine Rs.2.4.0 per gallon, or £1 13*s.* per cwt. (of 11 gallons packed).

In normal times at least 25 per cent. can be taken off these figures.

6. Further economies can be effected by proper arrangements for manufacture of tins for crude resin, of good casks for rosin and of good drums for turpentine. Machinery and special plant will be required, but with an expanding industry this should offer no difficulties.

7. So far in the Punjab resin industry the three retarding factors to rapid expansion have been paucity of labour, transport difficulties from forest to railhead, and lack of staff. The last is merely a question of administrative sanction. The first will improve after the war, as the most accessible pine forests are situated in some of the most heavily recruited districts in the province, viz. Rawalpindi and Kangra.

Transport has also suffered from war conditions, but the opening

out of bridle paths for mule and camel traffic, and of cart roads and the use of motor transport are possible solutions.

8. There remains the question of handing over the industry to private enterprise. In my opinion the arguments advanced by the Forest Economist and quoted in the Imperial Institute Report (see page 38) have considerable force and are difficult to answer as regards the forest part of the operations. As regards actual distillation and disposal of manufactured products by private agency, there seems little or no objection to Government handing over the resin at railhead at a fixed royalty per maund, and leaving the rest to the firms concerned.

November 1918.

APPENDIX IV

The following letter from Mr. W. F. Perree, Conservator of Forests, has been forwarded to the Committee by the Government of India:

I have the honour to refer to the Annual Progress Report of Resin Industry in the United Provinces for the financial year 1917–18. The financial year coincides with a complete season's operations, and a separate report has now been introduced covering the whole season's work instead of dealing with portions of two working seasons, as had hitherto been the practice.

2. Anticipating the necessity for detailed information on the resin industry, the above report has been drawn up in great detail and exhibits the cost of collection and manufacture with great minuteness, while the appendices contain interesting statistical data of the industry for the past ten years. It thus brings up to date the statistics contained in *Forest Bulletin*, No. 26, on the Resin Industry in Kumaun, by Mr. E. A. Smythies, I.F.S.

3. Dealing with the interim Report of the Special Committee on Gums, Resins and Essential Oils, it may be pointed out that in the section on the "Production of Turpentine and Rosin in India," the reference to the extension of the industry in the United Provinces by the erection of a second factory at Tanakpur no longer represents the present policy. The present factory at Bhowali is being closed and a new factory is being erected at Bareilly, the intention being to cope with the whole of the resin production of the United Provinces at this new factory. The past season's crop (1918) exceeds 90,000 maunds, and next year's is estimated at 120,000 maunds, which represents the capacity of the new plant, although the general lay-out admits of extension to a capacity of at least 300,000 maunds.

4. As regards the imports of resin products into India, it may be pointed out that the Indian demand for resin appears to have

reached its maximum in 1912–13 (113,000 maunds) while the normal annual demand may be taken at about 100,000 maunds. Of this the United Provinces will be in a position to supply 80,000 during 1919, leaving the balance of 20,000 maunds for the Punjab. It must, however, be borne in mind that Indian rosins are of a pale amber colour and cannot therefore replace the red rosins produced in America. It is estimated that not more than 50,000 maunds of United Provinces rosin can be disposed of in India, leaving 30,000 maunds for export.

5. As regards turpentine, the highest consumption appears also to have been reached in 1912–13, when 311,328 gallons were imported and locally manufactured.

The United Provinces resin crop of 1919 is estimated to yield 240,000 gallons, so that the country is within measurable distance of total independence from outside sources of supply. It must, however, be borne in mind that paint and varnish are now being manufactured in India, and further extension of this industry is also likely to take place. It does not therefore appear that much turpentine will be available for export to Europe, especially in view of the prospective demand in Mesopotamia, Africa, Further India and Java.

6. In the section on " External Markets for Indian Turpentine and Rosin " it may be pointed out that the Forest Department has already carried out extensive investigations with a view to the supply of foreign markets. So far, however, only small consignments to Java and South Africa have been possible because the quality of the rosins manufactured at Bhowali is inferior and it has been considered advisable to await the erection of our new plant, which will remove existing defects in our rosin. The same reason applies in a measure to turpentine, although our production has not so far overtaken the local demand. The quantity of rosin and turpentine hitherto available for export has been insignificant, and it is held that canvassing of foreign markets is of little use until the materials are available. Enquiries and lengthy correspondence with a view to business in the dim future seldom prove fruitful, although the time has now come for action in connection with rosins. As already stated, this subject has been receiving attention.

7. In the present position of shipping, export to England is scarcely possible, and the demand in Europe is more likely to be met from the large stocks of naval stores known to be held in America. The Indian resin industry can therefore only be expected to relieve the English market by satisfying the demand in India and adjacent countries and adding to the total world's supply. In any case, the suggestion to send samples of our products to London cannot be recommended until standardised products of turpentine oil and rosin can be assured at the new factory. To

send Bhowali manufactures could only result in failure. I therefore urge that action in this direction be postponed for the present.

8. In "The Development of Turpentine and Rosin Production in India" the Committee aptly sum up the position in the following words:

"It seems clear that a considerable proportion of the pine forests in India cannot be utilised for the production of turpentine and rosin until better means of transport become available, and it is possible that much of the area will for many years be too inaccessible to be worked."

The present position is that pine forests within 100 miles of a railhead which are served by a good cart road can be profitably exploited, while forests devoid of cart roads cannot be worked to a much greater distance than twenty-five miles. At present the United Provinces pine forests are served by only one cart road. The question of expansion therefore depends both as to rate and degree upon the development of new lines of communication, including railways, ropeways and the use of motor transport.

9. The extent of pine forests in these provinces is considerable. The chir forests of Kumaun, Chakrata and the leased territories of Tehri-Garhwal exceed 700,000 acres. Estimating two-thirds of this area as containing trees of a size suitable for tapping and a normal crop of one maund per acre, the annual yield would be about 434,000 maunds of crude resin. The adjoining forest of Tehri-Garhwal would yield at least half this quantity, so that there is ample scope for the extension of the industry. As above stated, however, the position is wholly governed by the presence of suitable communications.

10. The section of the report on the "Mode and Cost of Working" appears to indicate that the Committee would advocate recourse to private enterprise in order to develop the industry. It must, however, be urged that the most important part of the industry lies in the forest work. Experience has clearly proved that this work cannot be entrusted to contractors without risk of serious injury to the trees and loss of output. The collection of rosin is largely a result of a good understanding between the Forest Department and the local people. The protection of the forests depends upon the continuance of these good relations, and there is grave risk that they would be disturbed by the introduction of private enterprise.

The analogy between pine and teak forests alluded to in the report does not hold. There is the important distinction that whereas fire does not destroy teak forests, it most certainly causes irreparable injury to pine forests under tapping, owing to the fierceness of the heat generated by the resin on the exposed blazes.

11 The cost of collection, packing, transport and manufacture

is clearly exhibited in the special report for 1917–18, and it would be useful to learn in what items or general direction economy can be effected. The industry is carried out as part of the duties of the ordinary forest staff. This alone ensures economy in comparison with private enterprise. The collection of the yield of over two million channels from some 90,000 acres scattered over an area of nearly 4,000 square miles of broken country, requires careful organisation and close control. Every channel must be freshened weekly throughout the season of six months, and, at the same time, the packing in sealed receptacles and transport, first by coolie or pack animal and then by cart, require constant and efficient supervision. The comparison of cost of production in France and America would probably be unfavourable to India owing to the difference in the nature of the country, and such comparisons as regards the details of collection would have little value.

12. Dealing now with the specific points of enquiry at the end of the Committee's Report and in recapitulation of much that has already been said above :

No. 1. The information for India as a whole is contained in the tabular statement at page 2 of Troup's Memoir on *Pinus longifolia*, Sylviculture Series, vol. i, part i. For these provinces and Tehri-Garhwal it is given in paragraph 9 above.

No. 2. From the foregoing it is clear that leases of pine forests are not advocated.

No. 3. The co-operation of private enterprise with Government in the development of the industry can be ensured by placing interested firms as prospective purchasers in direct communication with the Forest Officers controlling the industry. At present there can be little resultant business as the expansion of the industry cannot take place through lack of communications, and the Indian market can absorb the whole output of turpentine, while better markets for our excess rosin are probably at hand in Java, Africa and Australia.

No. 4. A reference is invited to the Report on Resin Industry for 1917–18, which contains all the available information. It must, however, be explained that the costs of collection, packing, and of manufacture have been affected by high prices of labour and all materials. It is difficult to forecast the eventual cost after stable conditions have been established. On the other hand, prices are certain to fall very appreciably.

An estimate of the cost of turpentine and rosin f.o.b. Indian ports, based on present prices, is as follows :

Rosin	Rs. 16.0 per maund.
Turpentine, No. I	Rs. 5.0 per gallon.
Turpentine, No. II	Rs. 4.0 per gallon.
Turpentine, No. III . . .	Rs. 3.0 per gallon.

It has, however, been explained above that only 30,000 maunds of rosin will be available in 1919–20. The whole outturn of turpentine can be disposed of in India.

13. With reference to the subject-matter of the Government of India's letter No. 657–63–4, dated the 19th October, 1918, I have already explained that the special Resin Report for 1917–18 brings all the information contained in Mr. Smythies' Bulletin up to date, but it goes much further in exhibiting the actual cost of working and the financial results. The information asked for by the Government of India is thus available in this report. There is one point relating to the expansion of the industry which may require some elaboration.

The Forest Department in the United Provinces has gradually extended this industry from a crop of 14,819 maunds of resin in 1908 to 67,862 maunds in 1917. The latest figures of the current year's crop indicate a total of 92,000 maunds. Next year a crop of 120,000 maunds is being arranged for. The new plant will be able to cope with this quantity.

The addition of one still would enable a crop of 150,000 maunds to be distilled. This represents approximately the limit within which tapping operations can be undertaken with existing and prospective communications. If the values of the produce continued high, the limit might be extended to 200,000 maunds; but in view of competition from outside, it would not be safe at present to exceed 150,000 maunds in these provinces, as the losses on the distant areas would possibly have to be paid for by the profits on the more accessible forests. The question is essentially one of market value and of cost of production, the latter being governed mainly by the nature of communications. The future of a possible export business cannot be usefully discussed until the world's markets have become stabilised and freights are once more available. To enlarge at present upon the financial prospects of an export business would at best be mere conjecture.

14. I must express regret at the delay in submitting this reply. It was thought advisable to await the result of the conference with the Munitions Board before formulating a reply, as it was not known to what extent Government requirements would affect this industry. The result of the conference has been to leave the position unaltered.

December 1918.

IV

THE PRODUCTION OF TURPENTINE OIL AND ROSIN IN INDIA

Summary of Special Information prepared at the Imperial Institute for the Committee

In India turpentine-yielding trees are numerous in the forests of the Himalayas, in the United Provinces, in Assam, Burma and the Punjab. Turpentine oil and rosin have been produced in India on a small scale for some years. The oil and rosin obtained are used locally, but the quantity produced is by no means sufficient, as is evidenced by the amount of these products, particularly rosin, annually imported from the United States and elsewhere. The chief source of Indian rosin is the Chir pine (*Pinus longifolia*, Roxb.), a species which must be distinguished from the American *P. longifolia*, Salisb., now usually known as *P. palustris*, Miller. The latter is the longleaf pine of the Southern United States, and is the chief source of American turpentine oil and rosin. The principal localities in India where tapping is now carried on are the West Almora, Naini Tal and East Almora Divisions of the Kumaun Circle, United Provinces, and the Rawalpindi and Kangra Divisions in the Punjab. Government factories for preparing turpentine oil and rosin have been erected in both provinces.

Distribution of Pine Forests in India

Pine forests occur in the mountains of India from Afghanistan through Kashmir, Punjab and United Provinces, to Bhutan and Assam, and in Upper and Lower Burma. Five species of pine are indigenous to India, and their distribution, according to Gamble (*A Manual of Indian Timbers*, 1902), is as follows.

Pinus longifolia, Roxb., the Chir pine, occurs in the Outer Himalaya and Siwalik Range, and also in the valleys of the principal Himalayan rivers, at an altitude

of from 1,500–7,500 ft. It extends westwards to Afghanistan and eastwards to Bhutan.

P. excelsa, Wall., the kail or blue pine, is found in the temperate Himalayas at 6,000–12,500 ft. It has a similar range to *P. longifolia* but is not indigenous in Central and North-Western Kumaun and Sikkim.

P. Khasya, Royle, the dingsa or khasia pine, occurs at elevations of 3,000–7,000 ft. in the Khasi hills and hills of the Lushai country of Chittagong in Assam, and in the Shan hills and hills of Martaban in Burma.

P. Merkusii, Jungh. and de Vriese, the tinyu, is essentially a Burmese species, and is found in the hill forests of the Shan States and Tenasserim at elevations of 500–3,500 ft.

P. Gerardiana, Wall., the neosia or Himalayan edible pine, is found in isolated areas on the inner dry and arid West Himalayas from the Niti Pass in Garhwal (United Provinces), westwards, to North Afghanistan.

So far as the present commercial production of turpentine and rosin in India is concerned, the only important species is *P. longifolia*, although smaller quantities are capable of being derived from *P. excelsa* and *P. Khasya*. It is not possible to state accurately the areas covered by these pines in India, as many of the forests have not been fully surveyed. According to Troup (*Indian Forest Memoirs, Sylviculture Series*, 1916, **1**, Part 1, p. 2), the area in which *P. longifolia* is more or less gregarious amounts to 2,068,530 acres (exclusive of the forests in Sikkim, Bhutan, Nepal, Mandi, the Frontier States and Afghanistan). The principal localities, with the area of *P. longifolia* forests in each case, are as follows :

Locality.	Area. *Acres.*
Gahrwal and Kumaun Himalaya, United Provinces	658,728
Tehri-Gahrwal State forests, United Provinces	368,667
Chakrata Division (Jaunsar, with Tehri-Gahrwal leased forests), United Provinces	54,955[1]
Kangra, North-East Punjab	166,947
Chamba State, North-East Punjab	10,000
Kulu, North-East Punjab	4,029
Bashahr, North-East Punjab	11,273
Simla Hills, North-East Punjab	37,401
Rawalpindi, North-West Punjab	41,000[2]
Hazara, North-West Frontier Province	23,000[3]
Kashmir, including Jammu and Poonch	692,480[4]

[1] *Workable area (for timber) only.*
[2] *Subject to revision.*
[3] *Reserved forests only.*
[4] *Roughly approximate only.*

Of the above-named regions, the tapping of pine trees for resin on a commercial scale is only being carried on at present in the Kumaun Division of the United Provinces, and in Rawalpindi, Punjab.

The area under *P. excelsa* is much less than that occupied by *P. longifolia*, the total in the United Provinces and Punjab being about 65,000 acres (*Forest Bulletin*, No. 24, 1913, p. 8). Troup estimates that altogether *P. excelsa* covers an area of 128,000 acres in India, all of which is under the control of the Forest Department (*Work of the Forest Department in India*, 1917). According to the former publication, the largest areas, each between 13,000 and 14,000 acres in extent, are in the Hazara Forest Division, Jubal State forests (Simla Division) and Bashahr Division, all in the Punjab. Other areas in the latter province include the upper Ravi forests, Chamba Division (8,250 acres); Pangi leased forests, Chamba State (6,000 acres); Tharoch State forests, Simla Division (1,700 acres); and Kangra Forest Division (200 acres). In the United Provinces *P. excelsa* occupies an area of 4,740 acres in the Tehri-Gahrwal leased forests and 3,500 acres in the Government forests in Jaunsar Bawar.

As already mentioned, *P. Khasya* occurs in Assam, where the available area is stated to be 33 sq. miles, and in Burma. In the latter province, *P. Merkusii* also occurs. The following particulars as to the area under these two pines in Burma are taken from *Forest Bulletin*, No. 24, 1913, pp. 2–3:

Locality.	Area. Sq. miles.	Species of Pine.
Tenasserim Circle	50	*P. Khasya* (pure and mixed with deciduous trees).
Mongtung (Northern Shan States)	75	Not stated.
Myelat States (Southern States)	300	*P. Khasya.*
Lawksawk State (Southern States)	300	,,
Loilong and Mongpai State (Southern States)	300	,,
Mongpawn and Laihka (Southern States)	150	,,
Mong Kung State (Southern States)	300	,,
Hsatung State (Southern States)	50	*P. Merkusii.*
Mongnai State (Southern States)	100	Both species; probably 70 per cent. *P. Merkusii* and 30 per cent. *P. Khasya.*
Mawkmai State (Southern States)	100	
Mongpan State (Southern States)	600	
Kengtung (Mongpu and Monghsat) (Southern States)	800	

The Deputy Conservator of Forests in the Southern States considers that of the 3,000 sq. miles under pine

in his division, 1,400 sq. miles might be worked under the present conditions of transport.

In addition to those included in the foregoing table, very large forests of pine exist in the Maing Lon State to the south of Mogôk (Southern Circle), and pine is also said to occur in the Pakôkku Hill Tracts and Chin Hills, but the area in these cases is not known. There is an inconsiderable pine area in the Northern Circle of Burma, the total area in the Myitkyina, Lower Chindwin, Myittha, and Upper Chindwin Divisions being not more than 6 sq. miles.

In the case of all the species of pine referred to in the preceding pages, the area which can be profitably worked at present for the production of rosin and turpentine is considerably less than that given, but no figures of the available area appear to have been published.

Present Position of the Turpentine and Rosin Industry in India

As already mentioned, the tapping of pine for the production of oleo-resin on a commercial scale is being carried on in the United Provinces and in the Punjab. In both cases the tapping of the trees and the distillation of the oleo-resin are being conducted by the respective Forest Departments, whilst the sale of the turpentine and rosin in both provinces is under the control of the manager of the distillery in the United Provinces. It is stated that an English firm have been appointed agents in India for the sale and export of turpentine and rosin.

United Provinces.—According to E. A. Smythies ("The Resin Industry in Kumaun," *Forest Bulletin*, No. 26, 1914), the first experiments on the utilisation of the extensive pine forests of Kumaun, in the United Provinces, for the production of turpentine and rosin, were conducted by the officers in charge of the Forest College at Dehra Dun about 1890. By 1895 it had been established that oleo-resin could be obtained in workable quantities from the Chir pine (*Pinus longifolia*, Roxb.), and that the turpentine and rosin obtained were readily saleable. In the following year tapping operations were

started in the Naini Tal Forest Division, a commencement being made with 10,000 trees. A distillery was erected at Bhowali, where there is an excellent supply of cold water, whilst the surrounding oak and pine forests afford adequate supplies of fuel and timber. It was found, however, that the plant at Bhowali was out of date and unable to produce the best quality of rosin or give the full outturn of turpentine. Consequently, the construction of a new distillery with a modern plant on the Ropars (French) system, similar to that at the Jalloo factory in the Punjab (see p. 62), has been erected at Clutterbuckganj, near Bareilly, and commenced working early in 1920.

The growth of the industry in the United Provinces was at first comparatively slow, the output of crude oleo-resin rising from 125 tons in 1903–4 to 618 tons in 1911, but when, after fifteen years' working, it had been established that the tapping operations, as carried out by the Department, did no harm to the standing trees or the forest, arrangements were made to develop the industry as completely and rapidly as possible. Since 1911 there has been a marked increase in the output of crude oleo-resin, the quantity produced in each subsequent year being as follows: 1912, 1,030 tons; 1913, 1,547 tons; 1914, 1,679 tons; 1915, 1,990 tons; 1916, 2,288 tons; 1917, 2,493 tons; 1918, 3,431 tons; 1919, 3,745 tons.

The total area of forest worked in 1917–18 amounted to 77,972 acres; 1,405,425 trees were tapped, and the number of blazes or channels was 1,943,049. The yield of crude oleo-resin per 100 channels during the crop year 1917 amounted to 286 lb.; in the season 1918, when the weather was favourable for a high production of resin, the yield per 100 channels was 376 lb.; but in 1919 it fell to 294 lb. The output of rosin from the Bhowali distillery in 1919–20 was 1,559 tons, and of turpentine 81,448 gallons, of which 67,521 gallons was of Grade I quality. The net trading profit during 1919–20 was relatively low, viz. £5,162, owing to special causes. The figures for earlier years are: £35,627 in 1918–19; £31,845 in 1917–18; £20,730 in 1916–17; £10,115 in 1915–16; and £4,293 in 1914–15. These values are calculated at the normal rate of exchange for the rupee, viz. R.1 = 1*s.* 4*d.*

The chief difficulty experienced in connection with the industry in Kumaun is the transport of the crude oleo-resin to the factory. Some of the areas being tapped are at a distance of 80 miles by cart-road and a further 20 miles by foot-path from the distillery. Altogether, tapping operations for the supply of oleo-resin to the Bhowali distillery extend over an area of not less than 2,000 sq. miles, but of this not more than 400 sq. miles are pine forest. The difficulty in obtaining sufficient carts for the transport of the oleo-resin to the rail-head is said to necessitate the employment of mechanical transport of some kind, such as tank lorries, if the roads can be sufficiently improved to take them.

The tapping of pine trees was, until recently, conducted also in the Chakrata Division of the United Provinces, 50 tons of oleo-resin being collected in 1915–16. There is a distillery at Kalsi, but the stills are obsolete, and it was closed down in 1914. The trade during the next year or two was in oleo-resin only, but the demand for this fell off, and it would not pay to transport it by rail to Bhowali for treatment. Tapping has therefore now been discontinued in this division, and it is stated that unless a cheap method of extraction is discovered, the leased forests of Tehri-Garhwal will not pay to tap (*Rep. Forest Admin., U.P.*, 1915–16).

Punjab. — Tapping operations in the Punjab are at present confined to the Rawalpindi forests in the north-west part of the province and the forests of Kangra in North-East Punjab. As in the case of the United Provinces, the chir pine (*Pinus longifolia*) furnishes the whole of the oleo-resin obtained in the Punjab. Experiments have been conducted in tapping the kail pine (*P. excelsa*) in Bashahr, but the results were not very satisfactory. The yield of oleo-resin was relatively small as compared with that from the chir pine, whilst the cost of extraction from the comparatively remote kail areas of Bashahr raised the cost of production of the turpentine and rosin to a high figure. It was decided, therefore, not to work the kail forests for the present (*Progr. Rep. For. Admin., Punjab*, 1912–13).

The pine forests of Kangra appear to have been first

worked by Departmental agency for oleo-resin in 1897–8, a factory being erected at Nurpur in 1899. During the five or six years the factory was working, from 150–180 tons of oleo-resin were distilled annually, yielding 110–150 tons of rosin and 7,000–9,000 gallons of turpentine. After the first two years the factory showed a fair profit, but as there was a good demand for the oleo-resin, and as the latter could be sold to better advantage than could the finished products, it was decided to close the factory from April 1, 1905, and that tapping in Kangra should be restricted to trees destined to be felled, except for a small experimental area. Tapping was recommenced in this division in 1916–17.

In 1909–10 tapping was started in Rawalpindi, and in the following year a central factory was established at Shahdara on the Ravi River, four miles north of Lahore, with a plant capable of dealing with 10,000 maunds (367 tons) of oleo-resin per annum. In 1914 the factory was seriously damaged by floods, and it was decided to remove it to Jalloo railway station, nine miles east of Lahore, on the Lahore–Amritsar railway, where an entirely new plant of French design was installed. In 1918–19 it was decided to enlarge this factory, and a second Ropar's unit was ordered.

The output of crude oleo-resin in the Punjab in 1918–19 amounted to 986 tons, as compared with 846 tons in 1917–18 and 675 tons in 1916–17. Altogether 1,057 tons of crude oleo-resin were distilled at Jalloo in 1918–19. The yield in that year, excluding that obtained from 97 tons of crude resin distilled for the United Provinces, was 684 tons of rosin and 52,701 gallons of turpentine, as compared with 597 tons of rosin and 46,709 gallons of turpentine in 1917–18, 586 tons of rosin and 41,098 gallons of turpentine in 1916–17, and 447 tons of rosin and 31,445 gallons of turpentine in 1915–16. The net profit in 1918–19 was £16,078, or £1,974 more than in 1917–18, and £8,335 more than in 1916–17.

The chief obstacles to rapid progress in the resin industry in the Punjab are the scarcity of labour, the lack of staff, and difficulties connected with transport from forest to rail-head. It is anticipated that the two first

obstacles will be removed in the near future, but the transport question presents a more difficult problem to solve. During 1917–18, 14,521 acres of forest were tapped, but it is estimated that if the above-mentioned obstacles could be removed, tapping operations could be extended at once to about five times this area in the Punjab and North-West Frontier Province, and that the yield of rosin and turpentine could be increased in similar proportion.

Assam and Burma.—Although there are considerable areas of pine forests in Assam and Burma (see p. 56), tapping of the trees does not yet appear to be carried on in either province. With a view to establishing the industry in Assam, however, an area of 24 sq. miles in the Mylliem State was reserved for the growth of *Pinus Khasya* in 1914–15, and seed has also been supplied by the Forest Department to the native chiefs of other small states in the Khasi Hills who had set apart areas for the growing of pine.

Methods of Tapping and Distillation in India

Many of the forest officers who started the oleo-resin industry in India were trained in the French forestry schools, and the " cup and lip " method of tapping pines in use in France was naturally adopted in India. This method is usually regarded as better than the American " box " system, as the best possible yield of oleo-resin is obtained with the minimum risk of injury to the tree.

In Kumaun (*Forest Bulletin*, No. 26, 1914), tapping commences about March, and the cut is freshened about every six or seven days (five times a month) throughout the summer. The tapping continues for five years and the trees are then rested for ten years, so that only one-third of the total area of pine forest is actually being worked at any one time. Most of the areas in Kumaun are being tapped lightly, one channel being put on trees between 3 ft. 6 in. and 4 ft. 6 in. in girth, two channels on those between 4 ft. 6 in. and 6 ft., and three channels on those over 6 ft. in girth. Those trees which are to be felled within five years, however, are tapped heavily, as many as eleven channels being put on them in some cases. A group of 2,000 trees which were " tapped to death " gave

a yield of 450 cwts. of oleo-resin during 1913, whilst under light tapping not more than 120 cwts. could have been expected.

The methods of tapping adopted in the Punjab agree essentially with those in Kumaun. Experiments have shown, however, that a short freshening period is economically sound, and an interval of four days between successive tappings is the standard now adopted in the Punjab.

Troup (*The Work of the Forest Dept. in India*, 1917) states that " it was in the factories and in the selection and devising of manufacturing methods best suited for the distillation of the Indian pine resin that the Forest Department found its hardest task, a task in which the Forest Research Institute at Dehra Dun and the Imperial Institute, London, gave much helpful advice and assistance." It was found that the comparatively primitive, direct fire-heat apparatus used in the distillation of the American oleo-resin was unsuitable for Indian oleo-resin, and in order to procure turpentine and rosin of good quality it was necessary to employ steam distillation, as is done in France.

The following description of the process of distillation adopted at the Jalloo factory in the Punjab is taken from Troup's publication previously referred to. The methods employed at the Bhowali factory in the United Provinces were somewhat similar, but the plant was not quite so modern ; a detailed description of the methods used at Bhowali is given in *Forest Bulletin*, No. 26, 1914. As already mentioned, a new distillery has been erected near Bareilly, which commenced operations in 1920.

The oleo-resin as received from the forests is first melted by steam, a little turpentine from a previous distillation being added to facilitate the process. On standing, the water, dirt and other impurities sink to the bottom of the vat, and the clean oleo-resin is drawn off into storage tanks, whence a measured quantity is passed into the still. The latter is steam jacketed and kept hot by steam under pressure, so that any desired temperature may be attained. Steam is injected into the still, and the turpentine and water vapours which

distil over are first passed into a trap still to catch any oleo-resin or rosin that may have come over and then into a condenser, the liquid turpentine and water being next separated in a mechanical separator. To ensure standard qualities, the turpentine is redistilled in a subsidiary still, and passed through lime water to remove any traces of resinous acids ; it was formerly dehydrated by filtration through anhydrous sodium sulphate, but as this process is thought to be a possible source of contamination, the last traces of water are now removed by storing the turpentine for a time in bulk. In order to dispense with redistillation, experiments are in progress on fractionating the distillate during the primary distillation. The turpentine is put up for sale in 5-gallon drums bearing distinctive stencil marks, bung-hole discs and labels to prevent tampering by retail traders.

The hot rosin in the still is drawn off by means of a valve and transferred to the rosin shed, where it is filtered through a layer of cotton wool and then run into casks, bags or tins while still moderately hot and fluid. The rosin is graded according to American standard into pale, medium and dark shades.

Characters of Indian Turpentine and Rosin

The composition and characters of Indian turpentine have been repeatedly the subject of investigation at the Imperial Institute, as well as at the Forest Research Institute, Dehra Dun, India. As long ago as 1896 a preliminary report by Professor H. E. Armstrong, F.R.S., on the oils obtained from the resin of *Pinus Khasya* and *P. Merkusii* was forwarded to India by the Imperial Institute (see *Technical Reports from the Imperial Institute*, 1903, p. 167), and since then reports on the crude oleo-resin, rosin and turpentine of *P. longifolia*, *P. excelsa* and *P. Khasya*, have also been supplied. In the following pages a summary of the results of these investigations is given ; for further details reference may be made to *Selected Reports from the Scientific and Technical Department, Imperial Institute*, Part II, *Gums and Resins* (*Colonial Reports—Miscellaneous*, No. 63 [Cd. 4971], 1909, p. 195) and *Bull. Imp. Inst.* (1911, **9**, 8 and 1912, **10**, 539).

Pinus longifolia

Oleo-resin.—A sample of oleo-resin from the Naini Tal Division, United Provinces, was received in 1908. The botanical origin of the material was not stated, but it was doubtless the product of *P. longifolia.* On steam distillation it gave a yield of only 12·7 per cent. by weight of turpentine oil, so that there had evidently been a considerable loss of oil during storage and transit. The yield of oil obtained on a commercial scale at the Bhowali distillery varies from 17½ to 19 per cent. according to the quality and freshness of the oleo-resin. A second sample examined subsequently gave a yield of 19 per cent. of oil as the result of long-continued distillation, a figure which is more in accord with that obtained in India.

Turpentine Oil.—In all, six samples of oil prepared in India have been submitted to detailed examination at the Imperial Institute, as follows :

No. 1.—From the Jaunsar Division, United Provinces. Received in 1907.

No. 2.—Prepared at the Bhowali distillery. Received in 1910. This sample had been prepared by distilling the resin with 70 per cent. methylated spirit over a gentle fire for 3½ hours.

No. 3.—This was prepared in a similar way to No. 2, but the distillation was carried out more rapidly, being completed in two hours.

No. 4.—Prepared at the Forest Research Institute, Dehra Dun. Received in 1911. In this case the oleo-resin was mixed with acetic acid and gently warmed, so that it became quite liquid, and was then steam distilled. The sample received was the crude oil.

No. 5.—Prepared as in the case of No. 4, but rectified.

No. 6.—This was part of a trial consignment of turpentine oil sent from India to a firm of varnish makers in London.

Samples Nos. 2, 3, 4 and 5 were prepared in the course of experiments conducted by the chemist at the Forest Research Institute, Dehra Dun, with a view to improving the quality of Indian turpentine. A detailed account of these experiments is given in *Indian Forest Records* (1912, **4**, 1).

The specific gravity and optical rotation of the oils as received at the Imperial Institute were as follows :

	1.	2.	3.	4.	5.	6.
Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$	0·869	0·871	0·868	0·868	0·866	0·867
Optical rotation in 100 mm. tube . .	−3° 2′	−0° 45′	−2° 10′	+0° 20′	−0° 40′	−7° 20′

In the case of Sample No. 1, a portion of the oil was distilled to remove the comparatively non-volatile matter, and the distillate was submitted to a long series of fractional distillations to separate the volatile constituents from one another. These distillations were made under diminished pressure, approaching a vacuum, so that the boiling was effected at temperatures not exceeding 100° C. in order that the constituents might not be altered by the heat applied.

The non-volatile matter amounted to about 6 per cent., but as the amount of non-volatile matter in turpentine oil slowly increases owing to atmospheric oxidation, it may have been less when the oil was first prepared.

The volatile constituents were separated into two portions, differing considerably in their boiling-points.

The portion with the lower boiling-point amounted to one-third of the total volatile oil, and was found to be laevo-pinene. Purified portions had a boiling-point of 157·5° C., a specific gravity at 15° C. of 0·862 compared with water at the same temperature, and a specific rotatory power $[a]_D = -42°$.

The remaining two-thirds was much less volatile and appeared to be mainly composed of a turpentine oil having a boiling-point of 173° C., a specific gravity at 15° C. of 0·867 as compared with water at the same temperature, and a specific rotatory power $[a]_D = +14° 6'$.

Samples 2–6 were fractionally distilled with the results given in the following table :

Percentage of Total Sample by Volume

Fraction boiling at :	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
165° C. or below .	1	1	—	—	—
165° C. to 167° C. .	54	55	43	56	32
167° C. to 170° C. .					39
170° C. to 173° C. .	25	28	40	33	14
173° C. to 175° C. .					4
Above 175° C. . .	12	9	11	6	7
Residue and loss .	7	6	6	5	4

Optical Rotation in 100 mm. Tube

Fraction boiling at :	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
165° C. or below	−9° 45′	—	—	—	—
165° C. to 167° C.	−5° 15′	−7° 15′	−5° 25′	−4° 40′	−14° 5′
167° C. to 170° C.					−8° 50′
170° C. to 173° C.	+2° 0′	+0° 20′	+2° 0′	+3° 0′	−2° 15′
173° C. to 175° C.					—
Above 175° C.	+6° 35′	+7° 5′	+8° 5′	—	—
Residue and loss	+10° 45′	+17° 25′	—	—	—

The above figures show that these samples, yielding practically no distillate below 165° C., are quite different from American turpentine oil, which should yield not less than 70 per cent. by volume between 155° and 160° C. They more nearly resemble Russian turpentine oil among those on the English market, as the following figures, which have been recorded for two samples of commercial Russian oil, indicate :

		1.	2.
Specific gravity at $\frac{15{\cdot}5°\text{ C.}}{15{\cdot}5°\text{ C.}}$		0·866	0·884
Optical rotation in 100 mm. tube		+14° 29′	+16° 20′
Fraction boiling at :			
145° C. to 160° C.	*per cent.*	4	2
160° C. to 165° C.	,,	12	16
165° C. to 170° C.	,,	43	36
170° C. to 175° C.	,,	20	18
175° C. to 180° C.	,,	11	7
180° C. to 185° C.	,,	3	4
185° C. to 190° C.	,,	2	2

In order to investigate further the turpentine oil of *P. longifolia*, a sample of oleo-resin was submitted to steam distillation at the Imperial Institute. The first fraction of distillate had a specific gravity of 0·867 at 15° C./15° C. and a rotatory power in a 100 mm. tube of $[a]_D = +0° 10'$, but the density and also the rotatory power of the subsequent fractions gradually rose, until a distillate was obtained having a density of 0·918 and a rotatory power of $[a]_D = +21°$.

By this long-continued distillation 19 per cent. by weight of turpentine oil was obtained, and probably the yield could have been slightly increased by carrying the distillation still further. As, however, the later distillates are of high specific gravity, it would not be advisable to carry the distillation to this point in actual practice, and the manufacturing yield from oleo-resin of the quality of the sample experimented with should not exceed 166 c.c. of oil, weighing 144 grams, from 1,000 grams of the oleo-

resin, *i.e.* about 14 per cent. by weight. This oil, which should have a specific gravity at 15° C./15° C. of 0·867, should be purified by redistillation before being put on the market as rectified turpentine oil.

The first fraction of oil obtained on distillation of the oleo-resin, having a rotatory power of $[a]_D = +0° 10'$, and a specific gravity of 0·867 at 15° C./15° C., was submitted to repeated fractional distillation under reduced pressure, and two products were thus obtained, viz. :

(1) Laevo-pinene, the characteristic terpene of French turpentine oil, which has a boiling-point of 156° C. and a rotatory power of $[a]_D = -37°$. It was estimated that this laevo-pinene amounted to 25 per cent. by weight of the entire oil, or a little less.

(2) A high-boiling product with a boiling-point of 173° C., a rotatory power $[a]_D = +12° 20'$, and a specific gravity of 0·867 at 15° C./15° C. This constituent when exposed to the air oxidises much more rapidly than laevo-pinene. A portion of this high-boiling liquid of such a high degree of purity that the rotatory power was not changed by fractional distillation was submitted to fractional crystallisation to see if any separation could be effected, liquid air being used to obtain the necessary degree of cold. The oil was twice frozen, but it was found that the two crops of crystals and the mother liquors all had the same rotatory power as the portion of liquid taken for freezing, which thus appeared to be a single substance. When the pure terpene from the high-boiling fraction was treated with dry hydrochloric acid gas it yielded crystals of sylvestrene dihydrochloride, but when tested with acetic anhydride and strong sulphuric acid it did not give the blue coloration of sylvestrene. Its specific gravity, moreover, was higher than that of sylvestrene, which is 0·848 at 20° C.

It would therefore seem that the high-boiling portion of the oil is mainly a single terpene, which is not sylvestrene, but nevertheless yields sylvestrene dihydrochloride when it unites with hydrochloric acid ; a circumstance analogous to that observed in the case of pinene which in a similar way yields camphene hydrochloride. The liquid thus appears to be a terpene related to sylvestrene

and hitherto undescribed, and it may possibly contain other terpenes very difficult to separate.

The results of the examination of the oil prepared at the Imperial Institute by Mr. H. H. Robinson (*Proc. Chem. Soc.*, 1911, **27**, 247) confirm those obtained with turpentine oil distilled in India. To sum up, therefore, it has been shown that *P. longifolia* oil consists of from 25 to 33 per cent. by weight of *l*-pinene, the rest being principally a terpene, boiling at 173° C., which yields sylvestrene dihydrochloride when treated with hydrogen chloride. If the distillation of the oleo-resin is pushed too far, other constituents, which do not distil at temperatures below 175° C., are included in the oil.

Simonsen has recently published a paper on the constituents of Indian turpentine oil from *Pinus longifolia* (*Jour. Chem. Soc.*, 1920, **117**, 570) in which he confirms and extends Robinson's work. Simonsen obtained from the oil a new bicyclic terpene, *d*-carene, which is evidently identical with the high-boiling terpene described by Robinson. He found that the oil consists largely of *l*-*a*-pinene and *β*-pinene, and that, in addition to *d*-carene, a tricyclic sesquiterpene, " longifolene," is present.

The turpentine oil from *P. longifolia*, containing as it does normally a large proportion of terpene boiling at 173° C., must always be inferior to the best French and American turpentine oils, consisting almost wholly of pinene boiling at 156° C. It is therefore very important that the inclusion in the Indian oil of constituents, which do not distil below 175° C., should be avoided, and this can only be done by carefully controlling the distillation of the oleo-resin and stopping it before these undesirable constituents begin to appear in the distillate. This conclusion is also borne out by the results of experiments recorded in *Indian Forest Records* (1912, **4**, 35). Oil produced by water distillation was collected in four fractions. The first three fractions, representing about 70 per cent. of the whole, were mixed and fractionated, and 75 per cent. passed over below 172° C., and 82·5 per cent. below 180° C. Of the fourth fraction, only 27·5 per cent. passed over below 172° C. and 59·5 per cent. below 180° C. The residue above 200° C. amounted to 12·5 per

cent. in the case of the first three fractions and 29 per cent. in the case of the fourth.

The quality of the Indian oil can be greatly improved by redistillation, and, as already mentioned, that produced by steam distillation at Jalloo and Bhowali is redistilled before being placed on the market.

Experiments were made at the Imperial Institute to compare the behaviour, on exposure to air, of the sample of rectified Indian turpentine oil referred to above (No. 5), with that of a sample of ordinary rectified turpentine oil purchased in London. It was found that the Indian oil evaporated more slowly, oxidised much more rapidly, and gave more oxidised residue than the oil purchased in London. In these experiments, quantities of 10 c.c. of each oil were exposed in glass dishes 8 cm. wide, with vertical sides 3·6 cm. high. In six days the oil bought in London had evaporated, leaving an immobile film of thick liquid, whilst the Indian oil left a layer of syrupy liquid, which became immobile two or three days later. After seven weeks the residue left by the Indian oil was still sticky where the layer was thick, and "tacky" where it was thin, whereas the London sample had dried to a thin, "tacky" layer. The Indian oil finally left 1¼ grams of residue, whilst the London oil left only ¼ gram.

The properties of the two oils were also compared by using them to prepare solutions of zinc resinate. On leaving the oils for seventeen days in contact with an excess of the resinate, the oil purchased in London proved to be the more powerful solvent of the two, giving a very thick syrupy liquid, which had to be diluted with more oil before it could be used; whilst in the case of the Indian oil only a thin syrupy solution was obtained. This thin solution, however, when painted on sized wood gave a very satisfactory varnished surface, so that it appears that the Indian oil can be used quite well for making certain kinds of varnish.

Rosin.—Two samples of rosin or colophony of *P. longifolia* prepared at Naini Tal, United Provinces, have been examined at the Imperial Institute, the first being received in 1905 and the second in 1910. No information was supplied as to the method employed in preparing the

first sample, but the second had been prepared by heating the rosin as it came from the still with 10·15 per cent. of its weight of crystalline alum, and then separating it again by filtration. A description of the method employed in the case of the latter sample, together with the results of other experiments on the clarification of Indian rosin, is given in *Indian Forest Records* (1912, **4**, 75).

Sample No. 1 was rather dark in colour, but No. 2 (clarified with alum) consisted of masses of transparent pale brownish-yellow rosin having the usual appearance and properties of rosin of good quality.

The results of the examination of the samples, compared with typical samples of American and Bordeaux rosins of commerce, are shown in the following table :

		Indian rosin.		American rosin.	Bordeaux rosin.
		1.	2.		
Melting point		75–85° C.	74° C.	—	—
Specific gravity		1·067	—	—	—
Moisture	*per cent.*	—	0·80	—	—
Ash	,,	0·125	0·15	—	—
Saponification value [1]		190	184	184	184
Acid value [1]		165	174	176	175
Unsaponifiable matter,	*per cent.*	5·0	—	6·5	—
Specific rotation		+9° 40′	—	+29° 5′	0·0

[1] *Milligrams of potassium hydroxide required for 1 gram of rosin.*

These results show that there is little difference in composition between Indian rosin and that produced in the United States and France. Provided that the composition is satisfactory, the value of rosin depends primarily on its colour, and on this basis Sample No. 1 would rank as of low grade. Sample No. 2 was of much better quality, and although not quite so pale as the best Bordeaux rosin, it would be classed with the " water white " grades of American rosin ; it was valued by a firm of merchants at £14–£15 per ton in the United Kingdom, the current value of American rosin of similar colour and quality at the time of valuation being £14 9*s*. per ton.

It is clear, therefore, that Indian rosin if properly prepared is little, if at all, inferior to American and French rosins. It is at present mainly used in India in soap-making and paper-making.

Pinus excelsa

Oleo-resin.—A sample of the crude oleo-resin of *P. excelsa* from the Punjab, received at the Imperial Institute in 1908, gave a yield of 20·6 per cent. by weight of turpentine oil. The latter had a specific gravity at 15° C./15° C. of 0·8613, and an optical rotation in a 100-mm. tube of + 35° 25′. A specimen examined at Dehra Dun gave a yield of 18·82 per cent. of oil, with a specific gravity of 0·8583 at 20° C. (*Forest Bulletin*, No. 24, 1913, p. 8).

Turpentine Oil.—A sample of the oil produced at Dehra Dun was examined in 1912. It was of pale yellow tint, and had an odour resembling that of the best American grades of turpentine oil, but rather more pleasant. It had the following constants :

Specific gravity at $\frac{15° C.}{15° C.}$	0·862
Optical rotation in 100 mm. tube . . .	+ 36° 40′
Specific rotatory power $[\alpha]_D$	+ 42° 30′

The oil was fractionally distilled with the following results :

Fraction boiling at :	Per cent. of oil distilled.	Optical rotation in 100 mm. tube.
157° C. to 158° C. .	74	+ 37° 10′
158° C. to 160° C. .	16	+ 36° 15′
160° C. to 170° C. .	7	+ 34° 10′
Residue and loss .	3	—

From these results it was clear that this sample of turpentine oil was of good quality ; 90 per cent. of the oil boiled within the narrow range of 157° to 160° C., and consisted mainly of dextro-pinene.

A sample of the redistilled oil was submitted to a firm of varnish-makers, and samples of the oil in its original condition to two firms of merchants. The reports obtained indicated that the oil, if redistilled before shipment in order to render it colourless, would be readily saleable in the United Kingdom. The merchants would not, however, express an opinion as to the exact commercial value of the oil without having an opportunity of seeing and testing bulk samples, and they suggested that for this purpose 1 ton of the oil should be shipped to London for trial. They pointed out that this would

also afford an opportunity of introducing the oil to manufacturers and of ascertaining its actual value for technical purposes.

The yellow tint exhibited by the oil examined at the Imperial Institute could be easily removed by redistillation, or it is possible, as suggested in *Forest Bulletin*, No. 24, 1913, p. 7, that a catch still between the main still and the condenser would arrest the impurities to which the discoloration is due. *P. excelsa* oil, when freed from the yellow coloration, is quite equal in quality to the best grades of French and American turpentine oil, and it is very probable that technical trials will show that the oil is equally suitable for industrial purposes.

Rosin.—A specimen of rosin prepared at the Imperial Institute from the crude oleo-resin of *P. excelsa* gave the following results on examination :

Saponification value [1]		194
Acid value [1]		170
Unsaponifiable matter	*per cent.*	9·0
Specific rotation		— 4° 48′

[1] *Milligrams of potassium hydroxide required for 1 gram of rosin.*

This rosin was of good quality, and quite suitable for use in soap-making and other industries.

Pinus Khasya

Oleo-resin.—The sample of oleo-resin of *P. Khasya* from Burma, reported on by Professor H. E. Armstrong in 1896, was a grey, thick, pasty mass. It gave a yield of about 13 per cent. by weight of oil on steam distillation, and had evidently lost oil since it was collected, as a sample previously examined by him had given a yield of 17 per cent. of oil. Resin from the Southern Shan States, examined at Dehra Dun in 1911, gave a yield of 17·8 per cent. of oil (*loc. cit.*, p. 5).

Turpentine Oil.—Judging from the results so far recorded, the turpentine obtained from the resin of *P. Khasya* from Burma differs in some respects from that obtained in Assam. The following table shows the constants of the oil from these two localities and the results of fractional distillation :

		Burma.		Assam.	
		1. (Armstrong.)	2. (Dehra Dun.)	3. (Imperial Institute.)	4. (Dehra Dun
Specific gravity		0·8627 at 20° C.	0·8559 at 29° C.	0·870 at 15° C.	0·8733 at 15° C.
Optical rotation in 100 mm. tube		—	—	— 4° 50′	— 2°
Specific rotatory power $[\alpha]_D$		+ 36° 28′	+ 34° 8′	— 5° 30′	- -
Fraction boiling at :					
150° C. to 155° C.	*per cent.*	—	76	--	3·5
155° C. to 160° C.	,,	—	20	—	67·0
160° C. to 165° C.	,,	—	—	—	24·0
162° C. to 163° C.	,,	—	—	25	—
163° C. to 165° C.	,,	—	—	57	--
165° C. to 169° C.	,,	—	—	11	--
Residue and loss	,,	—	4	7	5·5

Professor Armstrong did not give the results of fractionation, but stated that the oil boiled within a narrow range of temperature, near to 155° C., and that it appeared to contain a certain proportion of a constituent with a higher boiling-point.

The specific gravity and optical rotation of the oil examined at the Imperial Institute were as follows :

Fraction boiling at :	Specific gravity at $\frac{15°\,C.}{15°\,C.}$	Optical rotation in 100 mm. tube.
About 162° C. to 163° C.	0·869	— 1° 50′
,, 163° C. to 165° C.	0·870	— 4° 40′
,, 165° C. to 169° C.	0·871	— 10° 40′
Residue and loss	0·895	— 7° 30′

These results show that the oil of *P. Khasya* is a moderately good turpentine oil, boiling within a fairly narrow range of temperature. The optical rotations indicate, however, that it is a mixture of terpenes, and in this respect it differs from American and French turpentine, which consist mainly of *d*- and *l*-pinene respectively. The standards which have been suggested or adopted at different times for grading American turpentine oil show a good deal of variation. Coste (*Analyst*, 1908, **33**, 219) considers that a good American " box " turpentine oil should comply with the requirement that 70 per cent. of the oil by volume should distil between 155° and 160° C. More recently it has been recommended (*Bull.* No. 135, 1911, *Bur. Chem., U.S. Dept. Agric.*) that the following grades of American oil should be recognised : No. 1, of which 95 per cent. should distil below 170° C. ; No. 2, of which 90 per cent. should distil below 170° C. ; and No. 3, of which 60 per cent. should

distil below 170° C. It is evident therefore that, apart from its colour, the oil of *P. Khasya* did not compare favourably with the best grades of American turpentine, but was quite equal to the lower grades.

The oil examined at the Imperial Institute had a yellow tint, but this could be easily removed by redistillation.

A sample of the redistilled oil was submitted to a firm of varnish-makers, and samples of the oil in its original condition to two firms of merchants together with the oil of *P. excelsa*, and the remarks given on pp. 71–72 with reference to the latter oil apply equally to that of *P. Khasya*.

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